PB-219 474

ECONOMIC BENEFITS FROM AN IMPROVEMENT IN WATER QUALITY

S. D. Reiling, et al

Oregon State University
Corvallas, Oregon

January 1973

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EPA-R5-73-008
JANUARY 1973

Socioeconomic Environmental Studies Series

W73-07813

PB 219 474

Economic Benefits from an Improvement in Water Quality

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✓

SELFCTED WATER RESOURCES ABSTRACTS
INPUT TRANSACTION FORM

1 Accession Number
W73-07813

2 Subject Field & Group
05G, 06B

5 Organization
Department of Agricultural Economics, Oregon State University, Corvallis,

6 Title
Economic Benefits From an Improvement in Water Quality, (all caps)

10 Author(s)
Reiling, S. D.
Gibbs, K. C.
Stoevener, H. H.

16 Project Designation
EPA, ~~[illegible]~~ Project 16110 FPZ

21 Note
(73-008)
Copy available from GPO Sup Doc
as EP1.23/3, $2.10; microfiche
from NTIS as PB-219 474, $0.95.

22 Citation
Environmental Protection Agency, Socioeconomic Environmental Studies, report
~~number~~, EPA-R5-73-008, January 1973.

23 Descriptors (Starred First)
Benefits, *recreation*, water quality*, economics*, lakes, camping,
sport fishing, *Recreation demand, *Water quality control, *Oregon,

25 Identifiers (Starred First)
~~Recreation demand~~, travel costs, on-site costs, *Klamath Lake (Ore.)

27 Abstract
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Data collected at three other lakes with varied characteristics are used to derive a relationship between the number of visits to a site and the characteristics of the site. This relationship is then used to estimate the increase in visits to Klamath Lake that would be forthcoming with an improvement in water quality.

The impact of expanded recreational use of Klamath Lake upon the local economy is also estimated through the use of an input-output model of the Klamath County economy. (EPA)

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EPA-R5-73-008
January 1973

ECONOMIC BENEFITS FROM AN IMPROVEMENT IN WATER QUALITY

By

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Project 16110 FPZ

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Prepared for
OFFICE OF RESEARCH AND MONITORING
U. S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D. C. 20460

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402
Price $2.10 domestic postpaid or $1.75 GPO Bookstore

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This report introduces and empirically tests a new methodology for estimating the economic benefits accruing to society from an improved recreational facility. The specific facility under consideration is Upper Klamath Lake, Oregon, which presently has low water quality. The methodology draws upon previous work done in the evaluation of recreational demand; however, it focuses upon the individual recreationist and separates the traditional price variable into on-site costs and travel costs. The model is used to estimate the number of days per visit the recreationist will stay at the site as the water quality improves.

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This report was submitted in fulfillment of Project Number 16110 FPZ under the sponsorship of the Office of Research and Monitoring, Environmental Protection Agency.

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This report has been reviewed by the Environmental Protection Agency and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

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SECTION I

CONCLUSIONS

1. Improved water quality in Upper Klamath Lake, Oregon, would result in expanded use of the lake for recreational activities.

2. A new conceptual model is developed and used to estimate the demand for recreation at Klamath Lake. The traditional price variable is separated into travel costs and on-site costs, because recreationists react differently to changes in the two costs. When both costs are combined in a single variable, the effects are dampened and only the stronger effect is observed.

3. The methodology also focuses upon the individual recreationist instead of the population of recreationists. This avoids the necessary assumptions made in earlier studies concerning the characteristics and homogeneity of the population groups.

4. A relationship is developed to explain the number of visits to a recreational site with certain characteristics. This is accomplished by utilizing data gathered at three other lakes which possess different characteristics. The relationship is used to estimate the number of visits to Klamath Lake after its characteristics are improved. The manner in which the site characteristics are specified in the model is not considered to be entirely satisfactory. The use-intensities for the various water-related activities were used because the level of these activities are, to some extent, dependent upon the water quality and other physical features of the lakes. However, it would be more satisfactory to specify the model with respect to the biological and physical parameters of the lake directly, since the use-intensities may not depend entirely upon the changing parameters of the lake. Unfortunately, the necessary data were not available to specify the model in this manner.

5. It is estimated that, if the algae were removed from Klamath Lake, the net economic value of the lake would increase by $1,200,000 per year. In addition, the income of households in the county would increase $194,000 per year.

6. If, in addition to removing the algae, the water temperature of the lake were lowered and the beaches improved, the net economic value of the lake would increase by an additional $2.65 million. Thus, the value of the recreational benefits associated with the two-step improvement is estimated to be $3.85 million per year, while household incomes would be $542,000 higher annually.

SECTION II

RECOMMENDATIONS

Because of the unique shape of the demand curve derived in the study, more than one value can be interpreted to represent consumer's surplus. It is not clear at this time which value is correct. Since the interpretation used has such a significant influence on the final results, additional work on this problem is strongly recommended.

Throughout the analysis it is assumed that the expanded use of Klamath Lake for recreation will not affect the level of use of other lakes in the vicinity. This ignores the possibility of recreationists substituting one recreational site for another, and implies that the postulated increase in recreation at Klamath Lake represents a net increase of recreation in the area. This is, to some extent, an invalid assumption. Additional research is warranted to determine the degree of substitutability among recreational sites.

An attempt to incorporate the value of recreational equipment in the model as a substitute for the recreationist's current income was not successful. This effort was made because current income may not accurately reflect the recreational budget of the recreationist. Further work in this area is suggested.

Future use of the model to predict the demand for recreation at a site after its characteristics have been altered will require a better specification of the model with respect to these characteristics. Multidisciplinary work is clearly needed to accomplish this goal.

Most of the work done in determining the demand for publicly provided outdoor recreation has focused on the estimation of the number of days per visit "consumed" at a site. The problem of determining the number of visits an individual will make to a site in a specified time period has been ignored. Work in this area is needed because of the relationship that exists between days per visit and the total number of visits. A model which could determine both variables simultaneously would be very useful.

This study represents only the initial test of the new methodology. Refinements and further tests are warranted, and are presently being conducted.

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SECTION III

INTRODUCTION

Extensive research has been conducted by the staff at the Pacific Northwest Water Laboratory of the Environmental Protection Agency, on the physical and biological aspects of the water quality problem of Upper Klamath Lake. Aside from the strictly scientific benefits resulting from this work, it is directed toward finding techniques which would permit alteration of the biological processes in such a way as to improve the lake's water quality and its usefulness to man.

Upper Klamath Lake is located in south-central Oregon, near the city of Klamath Falls, which has a population of about 38,000 in its immediate vicinity. It is the largest body of fresh water in the State, being more than 30 miles in length and comprising a total area of more than 130 square miles. U.S. Highway 97 follows the eastern shore of the lake north of Klamath Falls for about 15 miles. The highway is used by tourists during the summer, since it is one of the principal routes to Crater Lake National Park. Usually one would expect such an accessible body of water to be a popular site for water-based recreation. However, this is not the case at Upper Klamath Lake. Although the lake now supports a limited amount of recreational activities, poor water quality renders the lake undesirable for large-scale recreational use. The poor water quality stems primarily from large concentrations of algae and warm water temperatures during the summer months.

A brief examination of some of Klamath Lake's physical characteristics may be helpful in identifying the present water quality situation. First, mud deposits, ranging in depth from a few inches to more than 150 feet, have accumulated on the bottom of the lake [Bartsch, 1968]. These deposits contain large concentrations of the primary nutrients necessary for algae growth, particularly nitrogen and phosphorus.

The accumulation of mud deposits has also decreased the depth of the lake. At the present time its average depth is less than ten feet. This precludes the formation of temperature stratifications and allows low wind velocities to cause sufficient water movement to keep the needed nutrients suspended in the water, where they can be utilized by the algae. The warm water temperatures also limit the size of the sport fishery of the lake. All of these factors adversely affect the water quality of Klamath Lake and retard its use as a recreational facility.

The Economic Problem

The ultimate problem facing the economist is to estimate how much it is worth to society to improve the water quality of Klamath Lake. Or, to restate the problem in a more general way, what are the benefits that would result from a water quality improvement at Klamath Lake?

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The benefits associated with water quality improvements at Klamath Lake are primarily recreational benefits. Although recreation is only one of many possible uses of land and water resources today, its importance is increasing as leisure time and the level of family income continue to increase. People appear to be willing to make considerable financial sacrifices, in terms of travel costs to the site and equipment purchases, to participate in outdoor recreation. Thus, the estimation of recreational benefits has become a very important factor in the evaluation of natural resource projects.

Of the various competing uses for natural resources, the evaluation of the economic benefits associated with outdoor recreation is especially difficult. Unlike many of the other uses for natural resources, an adequate market does not exist for outdoor recreation. That is, "outdoor recreation" is not a commodity that is purchased and sold at a given price. Instead, recreational resources have traditionally been considered a "free" commodity. This has necessitated the development of other methods for evaluating recreational benefits. Several methods have been used to estimate the demand for recreation with varying degrees of success. This study presents a method for estimating the demand for a recreational site which is new in several important aspects.

Another problem confronting the economist is the determination of which benefits should be included in the evaluation of a project. Other benefits, in addition to the recreational benefits already mentioned, can also be attributed to water quality improvements at Klamath Lake. For example, as the quality of water improves and Klamath Lake is used more extensively as a recreational facility, the local economy will be the recipient of some economic benefits. As more recreationists use the lake, additional goods and services will be purchased from the local community. As business activity in the community increases, household income will also rise. Thus, the community benefits indirectly from the improved water quality. The indirect or "secondary" benefits differ from the recreational benefits in that the latter accrue to the nation as a whole, while the former, as measured in this study, accrue only to the local region. Depending upon the prevailing conditions in the local and national economies, all or a part of the secondary benefits may also accrue to the nation as well as to the local region. However, it is difficult to determine the magnitude of the secondary benefits that should be included in the national accounts. The theoretical and empirical issues in the determination of secondary benefits, given the national viewpoint, are discussed in Beattie [1970, pp. 76-93], and will not be reconsidered in this study.

Estimation of the regional benefits may provide other useful information. For example, the local community may be willing to pay part of the cost of the project. The magnitude of secondary benefits would set the upper limit to the local community's willingness to participate in such cost sharing. Also, estimation of the regional secondary benefits is a prerequisite for estimating the level of these benefits that may be relevant from the national viewpoint.

Objectives

The specific objectives of this report are four-fold. The first is to present a methodology appropriate for determining the economic benefits accruing to society from the development of a recreational facility. The second is to determine the relationship between water quality and recreational use of a facility by using the new methodology. This makes it possible to predict the change in recreational use that would accompany a substantial improvement in water quality.

The third objective is to determine the economic benefits accruing to society in general as a result of water quality improvements and the associated increase in recreational use of Klamath Lake. The final objective is to estimate the benefits that would accrue to the local economy as a result of the hypothesized increase in recreation at Klamath Lake.

As the objectives indicate, the research presented in this report serves two purposes. First, it provides specific information concerning the feasibility of allocating public funds for water quality improvement in Upper Klamath Lake. Second, and perhaps more important, is the evaluation of the methodology presented herein, so that it may be applied to the estimation of recreational benefits resulting from water quality improvements at sites other than Klamath Lake.

Organization of the Report

The next two sections consider the theoretical concepts involved in the estimation of demand relationships for outdoor recreation. Conventional economic demand theory, and some of the previous work done in estimating the demand for outdoor recreation, are reviewed in Section IV. These topics provide the background necessary to introduce the new model used in this study. The theoretical model is also presented in Section IV.

Section V contains a discussion of the statistical model for recreational demand. Each variable in the model is discussed. Sampling techniques and measurement problems are also described. The application of the model is made in Section VI.

Section VII explains the procedures used to estimate the local economic impact of increased recreational use of Klamath Lake. Since input-output techniques are used to quantify the regional benefits, the theory of input-output analysis is explained briefly. The model of the Klamath County economy is also presented in Section VII.

Sections VIII and IX contain the empirical analysis and the results of the input-output study. Finally, the effects of two hypothetical improvements in water quality of Klamath Lake are estimated in Section X. This section utilizes the results obtained from the demand analysis as well as those resulting from the input-output study.

SECTION IV

A THEORETICAL MODEL TO ESTIMATE RECREATION DEMAND

Previous Work in Estimating the Demand for Recreation

Many outdoor recreational services are provided publicly. As the supply of these services has not relied upon the market system, the economic evaluation of the benefits derived from the consumption of outdoor recreation cannot depend upon the methods relevant for evaluating market goods. A different set of techniques has to be developed.

The estimation of the value of outdoor recreation has proceeded in two general directions. Both seek to determine the amount recreationists are willing to pay to be able to use a certain facility. One approach is the "direct" method of estimating the consumer's willingness to pay [Knetsch and Davis, 1966]. The recreationists are asked, by means of a personal interview, to state how much they would be willing to pay for the use of the recreational facility, rather than be excluded. The demand estimates obtained in this fashion are defensible on theoretical grounds, but the degree of reliability which can be placed upon the respondent's answers is often difficult to determine. Biases are likely to exist, especially when questions are asked which deal with matters of opinion concerning a person's activity that has customarily been regarded as "free".

One source of bias is the consumer's understatement of his preference for a facility if he fears that a charge may be levied for future use of the facility. He may feel that understating his level of benefits may enhance his possibility of enjoying the facility in the future while paying something less than his actual willingness to pay. On the other hand, if the recreationist feels that the recreational service in question will continue to be publicly provided without the levying of user fees, he may overstate his willingness to pay. In doing so, he may expect to combat competitive pressures for non-recreational uses of the facility and thus support the case for improvement and/or preservation of the recreational site.

One advantage of the direct method is that it is not restricted to estimating only the effective demand for outdoor recreation. It can also estimate the demand of those people who are not participating in the activity at the present time, but who may wish to participate at a later date. These people would be willing to pay to preserve the option of participating in the future. Unfortunately, measurement problems are also present here because of the hypothetical nature of the questions posed to the prospective recreationists.

The second approach for determing the amount recreationists are willing

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to pay for the use of recreational facilities relies upon the reactions of recreationists to changes in costs of participating in recreation at the recreational site. Willingness to pay can be computed from this "indirect" evidence. The procedure is limited in that inferences must be made to the entire population consisting of recreationists and non-recreationists; only the effective demand can be analyzed. This approach is utilized in this study.

Hotelling, in a letter published by the U.S. National Park Service in 1949, defined concentric zones around a recreational site in such a way that the cost of traveling to the site from a given zone would be approximately constant. His suggestion was to use the travel cost that existed within each zone as the price variable to be compared to the number of visitors from each zone. A demand function for recreation could then be obtained.

Although Clawson [1959] recognized problems in this formulation, he used the basic idea underlying Hotelling's approach and gave it an interpretation that further facilitated the measurement of recreational values. Clawson envisioned deriving two demand relations. The first was expressed as a relationship between the level of travel cost and the rate of participation of a population group derived in the manner suggested by Hotelling. From the first demand relation he derived a second demand schedule. The rate of participation from a given population group, for a certain fee increase, was predicted by referring to the observed participation rate of another population with travel costs equal to the travel cost of the group in question, plus the fee increase. A demand schedule for a population group was obtained by relating various fee increases to the resulting participation rates. The participation rates were multiplied by the number of people in the group to estimate the quantity of use from that population group. This procedure was repeated for each zone, and the resulting demand schedules were added horizontally to obtain the aggregate demand schedule for the recreational resource.

Brown et al. [1964] and Stevens [1966] further refined the Clawson model by incorporating income and the quality of the recreational experience into the model. Angling success per unit of angling effort was added as an independent variable. Work was also done on the inclusion of distance as a separate explanatory variable. However, it was found to be highly correlated with transfer costs, due to the manner in which transfer costs are defined.

Many important and restrictive assumptions are involved in the indirect approach discussed up to this point. First, it is implied that the reactions of recreationists to a fee increase would be identical to an equal addition in the cash cost of travel. No distinction is made between a recreationist's reaction to increased variable costs (daily costs while at the recreational site) and increased fixed costs (costs of travel). Secondly, in predicting a group's response to a change in costs by observing other groups, it is assumed that all of the groups, stratified by distance, face identical alternatives to the recreational resource in question. Thirdly, it is assumed that recreationists are the same in all other respects, in all distance zones, so that they will react in the same way to increases in the cost of travel.

This study presents an extension of the indirect approach to the evaluation of recreational resources. It should be noted that, independent of the construction of the theory found in this section, Pearse [1968] developed a very similar approach. His approach differs slightly in the technical development, and his application is entirely different. The theoretical development of the procedure used herein will be examined, with the focal point being the individual recreationist instead of a population group. This eliminates some of the restrictive assumptions made about the population groups in the Clawson method.

Conventional Demand Analysis

Before presenting the theoretical model used in this study to estimate the demand for recreation, it may be helpful to review the fundamental concepts of demand analysis. Economists and others familiar with demand theory may wish to proceed directly to the subsection entitled "The Theoretical Model Applied to Outdoor Recreation". Let us begin by assuming that there is one consumer and two commodities, Q_1 and Q_2. It is also assumed that the consumer prefers to have as much of each commodity as possible; that is, both commodities are considered desirable by the consumer. The objective of the consumer is to maximize his satisfaction, subject to a constraint - the amount of money he has available to purchase the two commodities in a given time period.

All possible combinations of commodities Q_1 and Q_2 the consumer could conceivably choose, if he were not constrained by a budget, can be envisioned in Figure 1 as lying above and to the right of the origin. This is referred to as the "commodity space". Every point within the commodity space represents a combination of commodities Q_1 and Q_2 that may be consumed.

The consumer is confronted with an infinite number of combinations in the commodity space. It is assumed that the consumer has the ability to rank all of the combinations in the commodity space according to the level of satisfaction that he receives from each of them. All of the information concerning the consumer's satisfaction is contained in his utility function. A utility function expresses the relationship between satisfaction, or utility (U), and the quantity of commodities Q_1 and Q_2 consumed:

$$U = U(q_1, q_2) \qquad (1)$$

where q_1 and q_2 refer to the amounts of Q_1 and Q_2 consumed. It is also assumed that the consumer is consistent in his rankings; if he prefers Combination B to Combination C, and C to A, he must also prefer B to A.

Indifference curves are a helpful analytical device. They are obtained

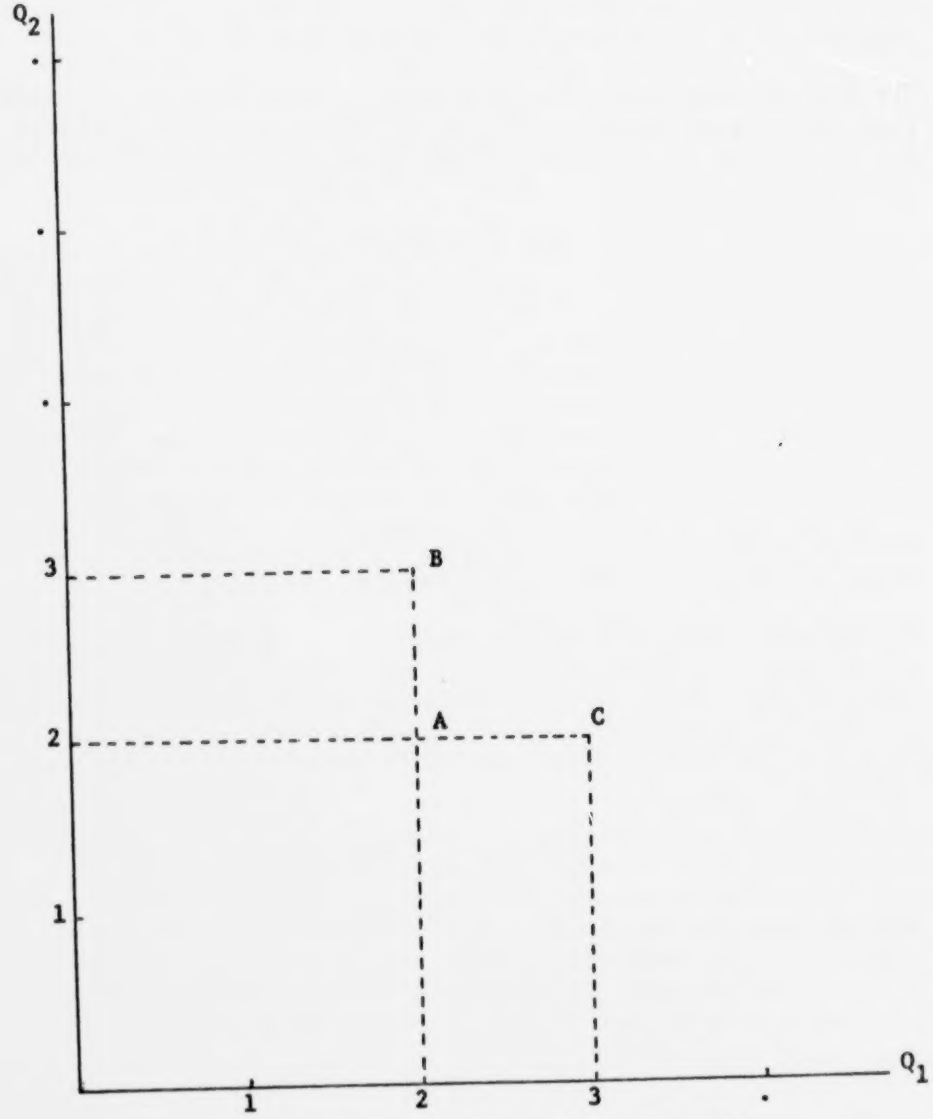

Figure 1. The Commodity Space for Commodities Q_1 and Q_2.

by holding the level of utility constant, and observing the various combinations of the commodities that are consistent with the fixed level of utility.

$$U_o = U(q_1, q_2) \tag{2}$$

where U_o refers to a constant level of utility. The indifference curve depicted by Equation (2) is shown in Figure 2.

The indifference curve shows the different combinations of Q_1 and Q_2 that yield equal satisfaction to the consumer; he is indifferent, or has no preference, between the combinations of Q_1 and Q_2 that lie on the indifference curve U_o.

It should also be noted that all combinations of Q_1 and Q_2 which lie above and to the right of U_o are preferred to those combinations along U_o, since the consumer enjoys more of at least one of the commodities. For example, Points B and C in Figure 2 yield a higher level of satisfaction than Point A, since the consumer has more of one commodity and the same amount of the other. Therefore, Points B and C must lie on higher indifference curves. Likewise, all points below and to the left of U_o are less preferred combinations of Q_1 and Q_2 than those located on U_o.

The indifference curve U_c in Figure 2 represents only one of an infinite number of indifference curves for the consumer. Figure 3 contains a portion of the indifference curves defined by the consumer's utility function. This is referred to as an indifference map. Again, the curves above and to the right of another indifference curve represent higher levels of utility or satisfaction to the consumer.

Some of the more important properties of indifference curves should be noted. The shape of the indifference curve can be ascertained from the total derivative of Equation (2):

$$dU_o = \frac{\partial U}{\partial q_1} dq_1 + \frac{\partial U}{\partial q_2} dq_2 \tag{3}$$

Setting Equation (3) equal to zero and solving for dq_2/dq_1 yields:

$$dq_2/dq_1 = - \frac{\partial U}{\partial q_1} / \frac{\partial U}{\partial q_2} \tag{4}$$

Equation (4) represents the slope of the indifference curve. Since the consumer prefers to have more of both commodities, $\partial U/\partial q_1$ and $\partial U/\partial q_2$ are positive. Therefore, the indifference curve has a negative slope. The second derivative of the utility function is positive, which means the curve is convex to the origin.

Another point worth noting is that indifference curves cannot intersect.

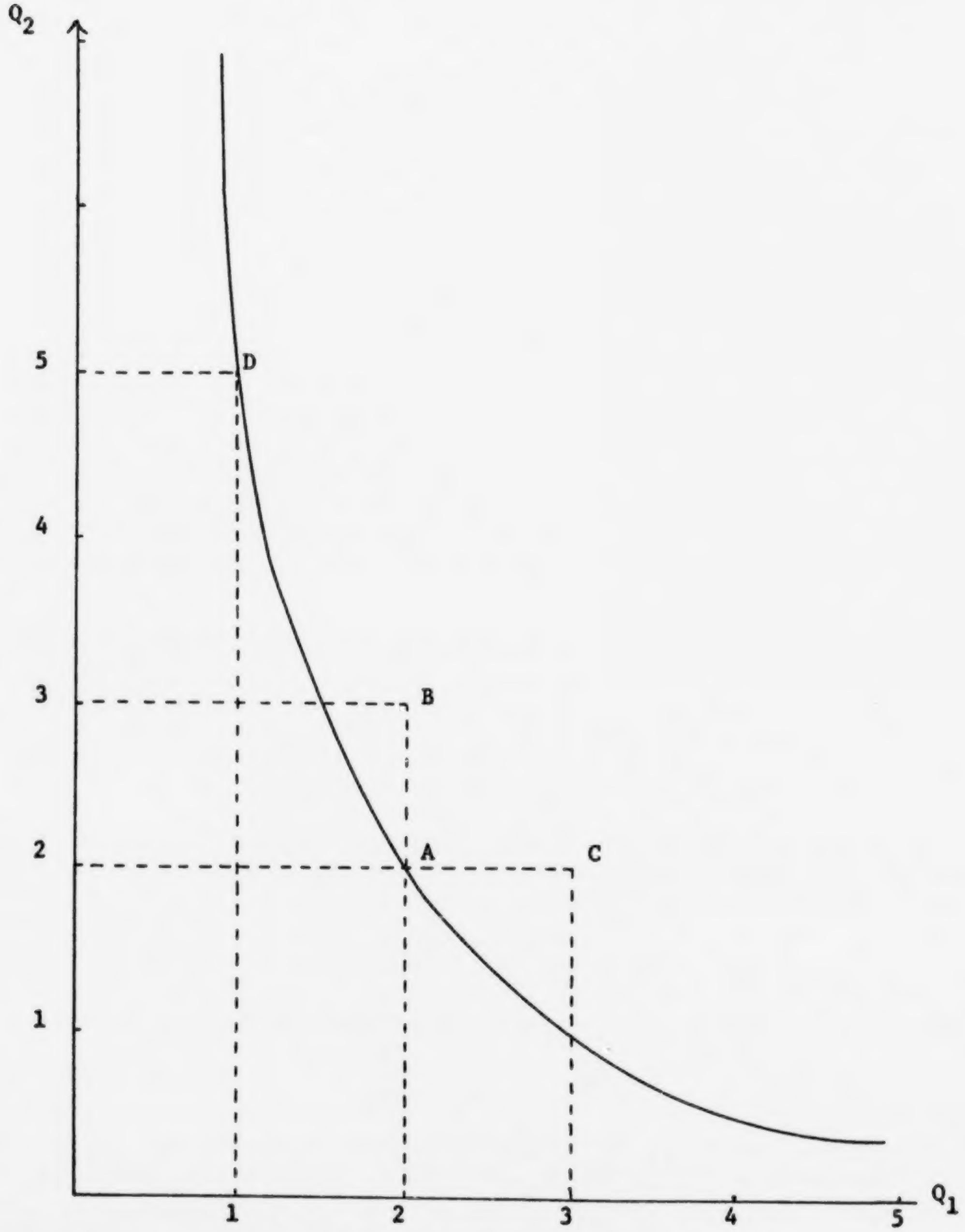

Figure 2. An Indifference Curve for Commodities Q_1 and Q_2.

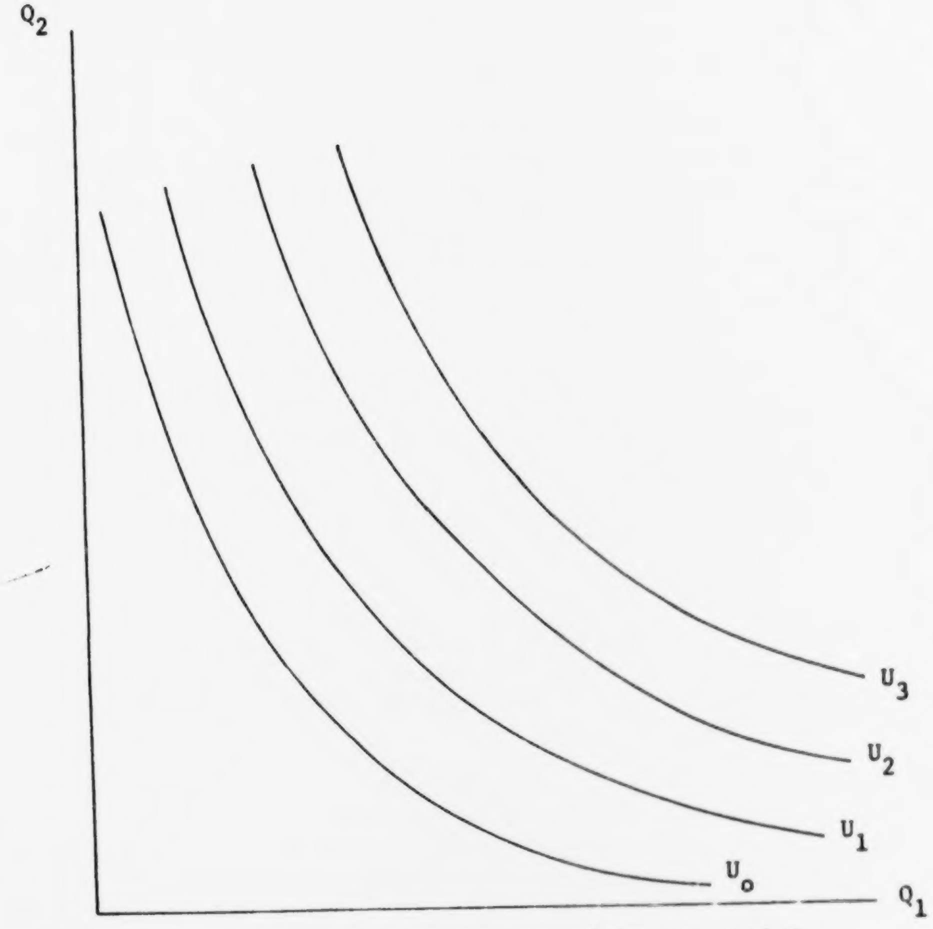

Figure 3. An Indifference Map for Commodities Q_1 and Q_2.

Since the curves reflect different levels of satisfaction, two curves cannot share a single combination of commodities. Two curves passing through the same point indicate that one combination yields two different levels of satisfaction to the consumer. Since it is assumed that the consumer has the knowledge to rank all of the combinations of commodities in the commodity space, such inconsistencies cannot exist.

Now that the concept of indifference curves has been introduced, let us return to the commodity space. It contains all possible combinations of commodities Q_1 and Q_2 that the consumer could conceivably consume. However, it may not be possible for the consumer to choose all of the points in the space, since he is constrained by the amount of money he has available to purchase the two commodities.

To determine the consumer's attainable set, assume that he has M_1 dollars to spend on commodities Q_1 and Q_2. If the consumer chooses to purchase commodity Q_1 only, he can obtain M_1/p_1 units, where p_1 represents the price of commodity Q_1. Similarly, if he chooses to purchase Q_2 only, he can obtain M_1/p_2 units. The budget constraint faced by the consumer is:

$$M_1 = q_1p_1 + q_2p_2 \tag{5}$$

Equation (5) is illustrated in Figure 4. The consumer is able to purchase any combination of the two commodities in the set bounded by the horizontal and vertical axes and by the line representing Equation (5). This portion of the commodity space represents the consumer's attainable set. The slope of the budget constraint can be determined from Equation (5):

$$\frac{dq_2}{dq_1} = -\frac{p_1}{p_2} \tag{6}$$

From Equation (6) and Figure 4, it can be seen that a change in the price of either commodity will change the slope of the budget constraint line. However, a change in the consumer's money income will cause a parallel shift of the budget constraint.

We are now ready to determine the "most preferred" combination of commodities Q_1 and Q_2. The consumer will choose the combination of commodities Q_1 and Q_2 to maximize his utility, given his income constraint. This is equivalent to maximizing the following function:

$$V = U(q_1, q_2) + \lambda(M_1 - q_1p_1 - q_2p_2) \tag{7}$$

where λ is the Lagrangian Multiplier. The conditions for maximizing constrained utility are fulfilled when the partial derivatives of Equation (7), with respect to q_1, q_2, and λ are set equal to zero:

$$\frac{\partial V}{\partial q_1} = \frac{\partial U}{\partial q_1} - \lambda p_1 = 0 \tag{8}$$

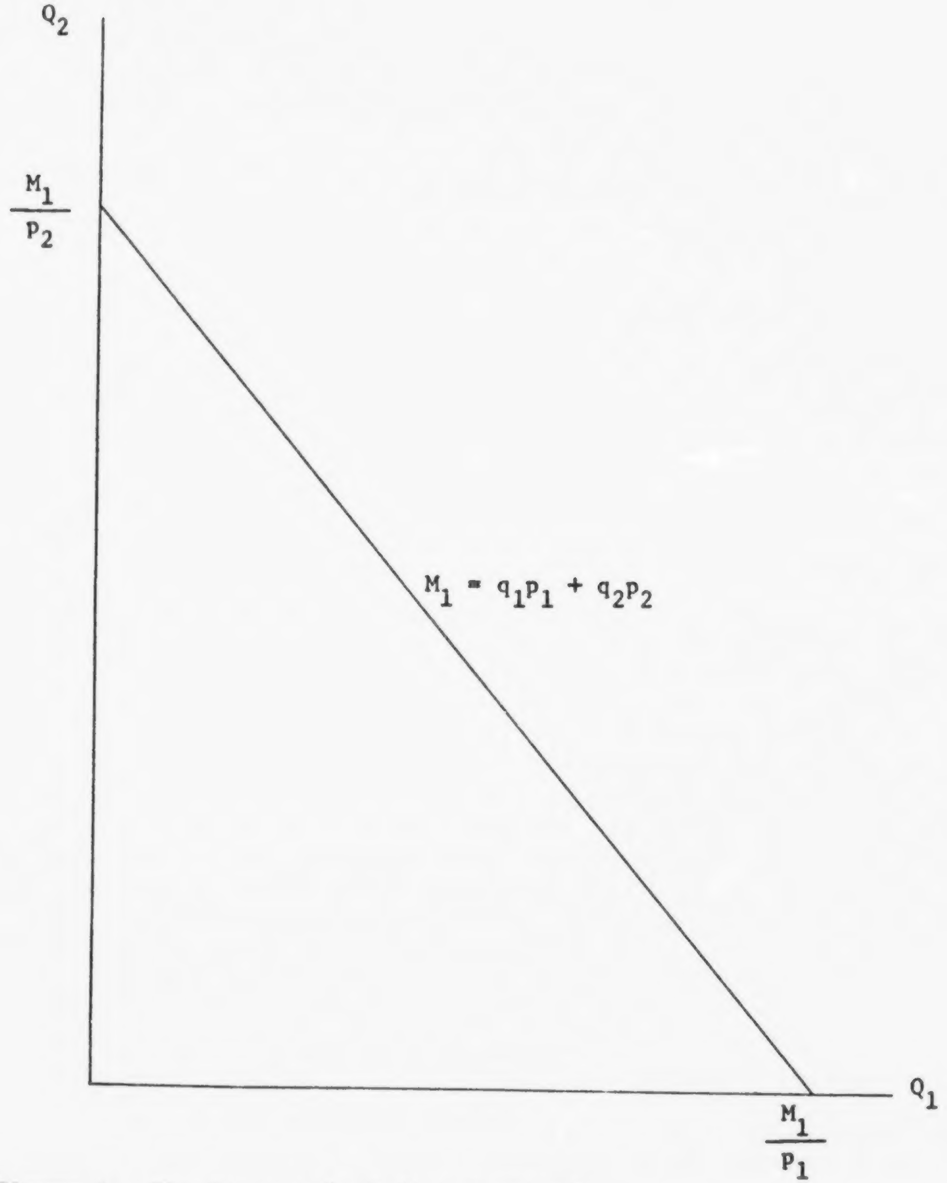
Q_2
$\frac{M_1}{P_2}$
$M_1 = q_1p_1 + q_2p_2$
Q_1
$\frac{M_1}{P_1}$

Figure 4. The Consumer's Budget Constraint.

$$\frac{\partial V}{\partial q_2} = \frac{\partial U}{\partial q_2} - \lambda p_2 = 0 \qquad (9)$$

$$\frac{\partial V}{\partial \lambda} = M_1 - q_1 p_1 - q_2 p_2 = 0 \qquad (10)$$

The consumer maximizes his constrained utility by consuming those quantities of Q_1 and Q_2 that satisfy Equation (10) and the following first-order condition:

$$\frac{\partial U}{\partial q_1} \Big/ \frac{\partial U}{\partial q_2} = \frac{p_1}{p_2} \qquad (11)$$

That is, Q_1 and Q_2 will be consumed until the ratio of their marginal utilities equals the ratio of their respective prices, and all income is spent.

The maximization of constrained utility is illustrated graphically in Figure 5. The consumer's budget constraint is superimposed on his indifference map. Money income is M_1, and the price of commodities Q_1 and Q_2 are p_1 and p_2, respectively. Indifference curve U_2 represents the highest level of utility that is attainable with the given budget constraint. Therefore, the consumer will maximize his utility by consuming q_1^o units of Q_1, and q_2^o units of Q_2.

The Demand Curve

The consumer's demand curve for a commodity is derived from his indifference map. A demand curve is a schedule that shows the various quantities that the consumer will purchase at various prices.

Assume the price of commodity Q_2 and money income are fixed at p_2^o and M_1, respectively, while the price of commodity Q_1 is varied. As shown in Figure 6, the quantity of Q_1 purchased will vary as its price varies. When the price of Q_1 is p_1^o, the consumer will purchase q_1^o units of the commodity. When the price of Q_1 increases to p_1' and p_1'', the individual will purchase only q_1' and q_2'' units, respectively. Thus, as the price of Q_1 increases, the consumer purchases less of the commodity. The individual's demand curve is derived by plotting the various prices and the respective equilibrium quantities purchased, as shown in Figure 7.

It should be noted that the derivation of the demand curve is contingent upon the continued optimizing behavior of the consumer. This is illustrated by the tangencies at Points A, B, and C in Figure 6. Any changes in the consumer's utility function, income, or the price of commodity Q_2 will shift the individual's demand curve for Q_1. A market demand curve for a commodity is obtained by horizontally adding the demand curves of all individuals in the market.

One other concept needs to be discussed before introducing the demand model for recreation. It is "consumer's surplus". Let us begin with

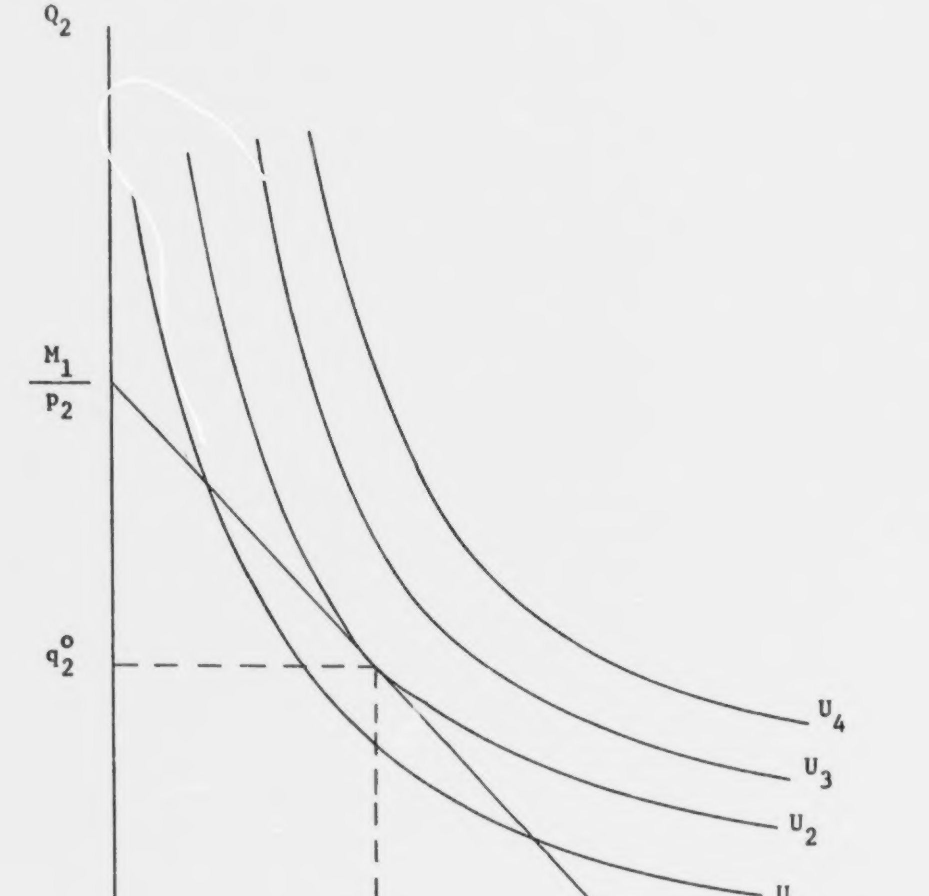

Figure 5. Maximization of Consumer's Utility.

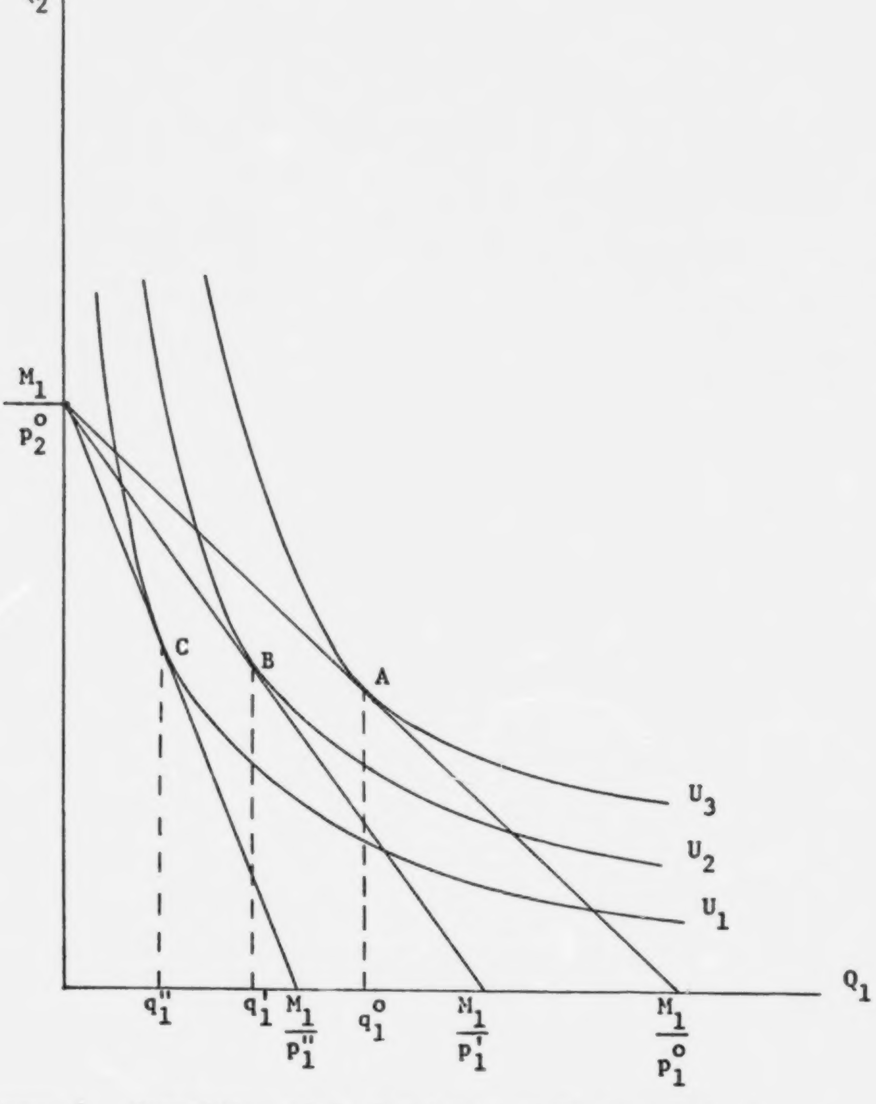
Q_2
$\frac{M_1}{P_2^o}$
C
B
A
U_3
U_2
U_1
Q_1
q_1''
q_1'
$\frac{M_1}{P_1''}$
q_1^o
$\frac{M_1}{P_1'}$
$\frac{M_1}{P_1^o}$

Figure 6. Quantities of Q_1 Purchased at Various Prices.

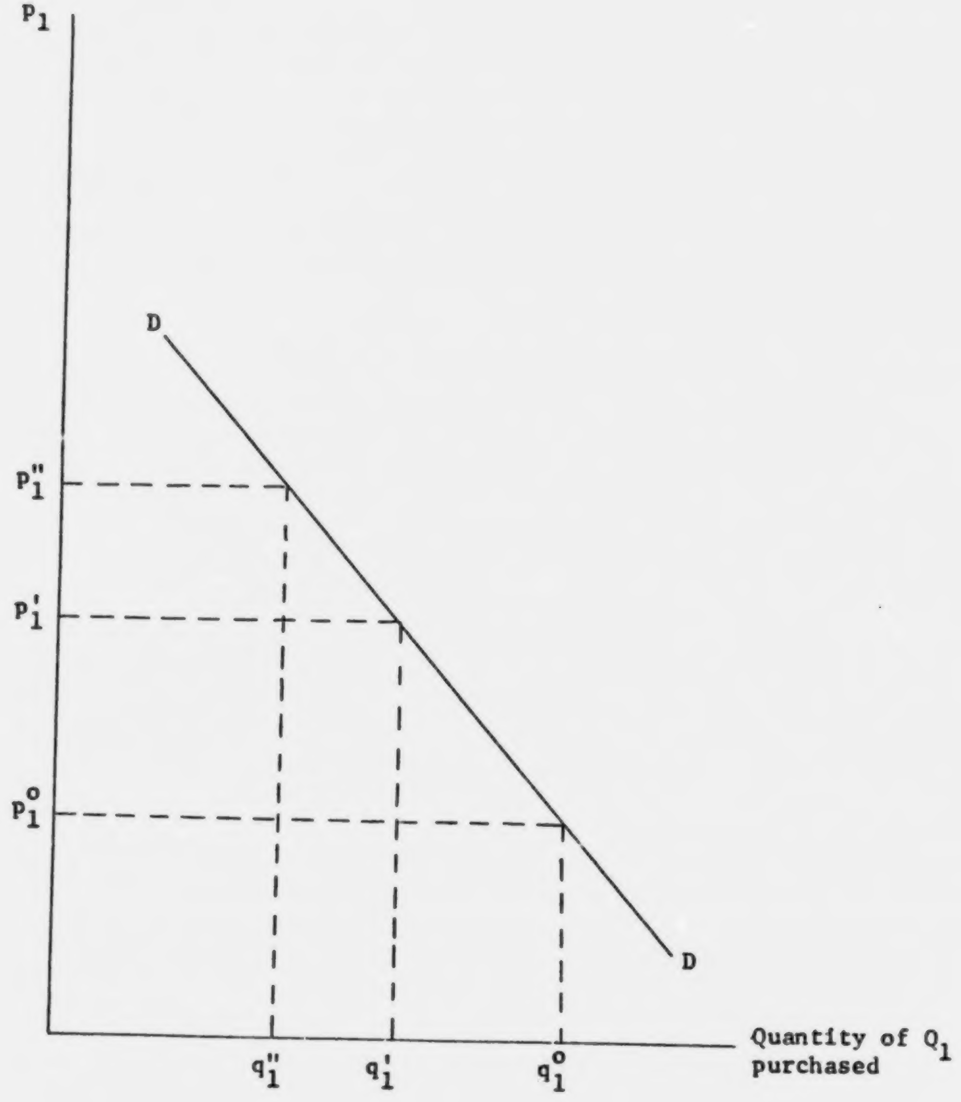

Figure 7. The Consumer's Demand Curve for Commodity Q_1.

the notion that a consumer pays a price for a commodity that is less than or equal to the benefit he receives from the commodity. This can be illustrated by an individual's demand curve DD, as shown in Figure 8. Assume that the market price for the commodity is two dollars. At that price, the consumer demands five units of the commodity. He pays two dollars for each of the five units of the commodity. However, the consumer's demand curve shows that he would be willing to pay more than two dollars for the first unit of the commodity. In fact, the consumer would be willing to pay six dollars. However, since the first unit, like all other units, is sold at the market price of two dollars, the consumer receives six dollars worth of satisfaction for only two dollars. Thus, he enjoys a "surplus" by receiving excess benefits from the first unit. The same situation exists for the second, third, and fourth units of the commodity; the consumer is paying less for those units than he would be willing to pay. Therefore, those units of the commodity result in a surplus to the consumer. The difference between the price the consumer is willing to pay for the units of the commodity and the price he actually has to pay for them is called "consumer's surplus". Consumer's surplus is used later in this study to estimate some of the values associated with the demand for outdoor recreation.

The Theoretical Model Applied to Outdoor Recreation

To analyze the economic behavior of recreationists, it is necessary to derive a model which will account for the number of visitor-days recreationists will take at various levels of expenditures. This will require a slight alteration of the conventional demand analysis outlined above. The theory conceptualized in this section comes from an unpublished paper by Dr. John A. Edwards, Department of Agricultural Economics, Oregon State University.

In the presentation above, it was assumed that to purchase a unit of either commodity, the consumer had to pay the relevant prices, p_1 and p_2. Now suppose the consumer must pay, in addition, a certain charge, or cost, referred to as k, in order to buy any units of Q_1. However, the value of k does not depend on the amount of Q_1 purchased.

Recreation is a good example where k is relevant. In order to enjoy any amount of recreation, Q_1, the recreationist must incur a certain price per day, p_1, while recreating. However, he must also travel to the recreational site. The travel costs, including the transportation cost, food, lodging, camping fees, etc., that occur while enroute to and from the recreational site, do not depend upon the quantity of Q_1 consumed, and will be referred to as k.

The recreationist will allocate his income in order to maximize his utility, U:

$$U = U(q_1, q_2) \qquad q_1, q_2 \geq 0 \qquad (12)$$

where q_1 indicates the number of recreation-days the recreationist enjoys at a particular site per visit, and q_2 represents the amount of all

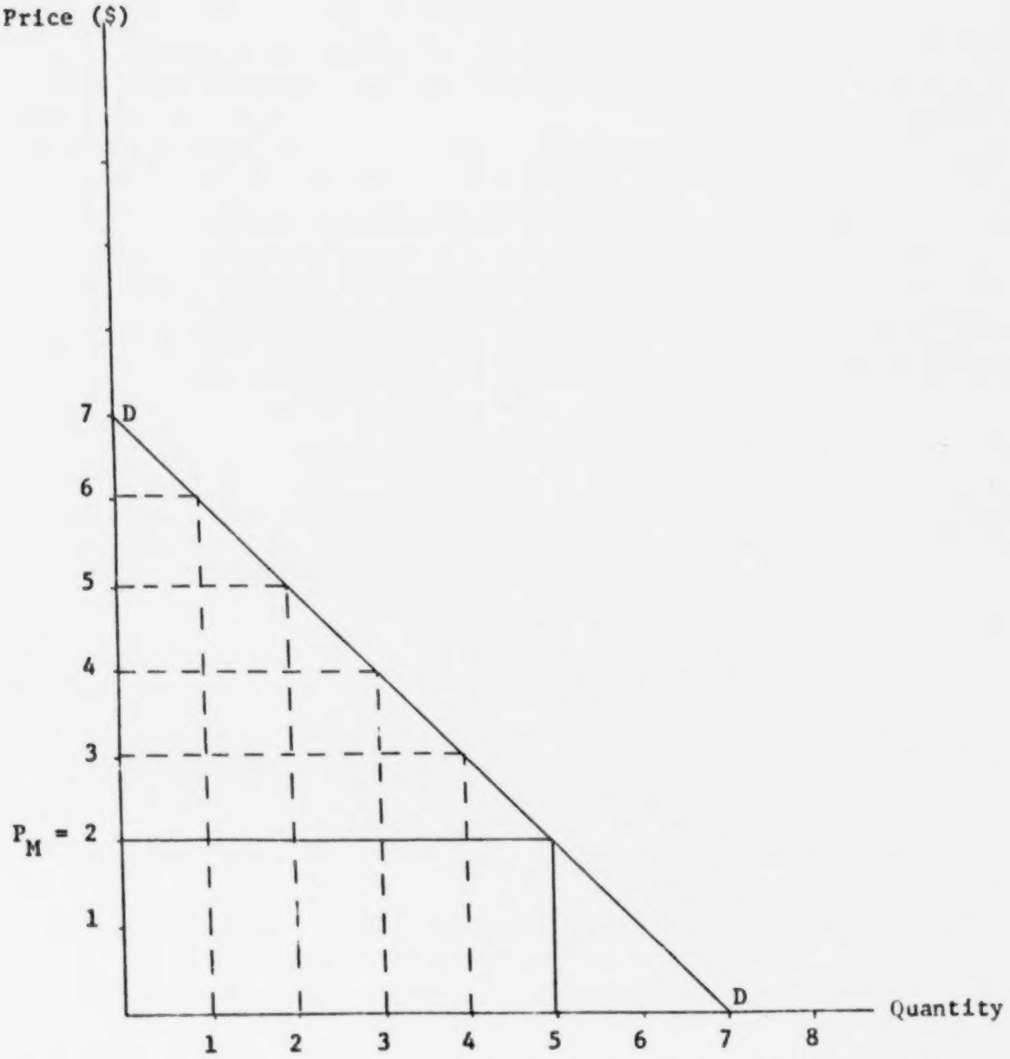

Figure 8. An Illustration of Consumer's Surplus.

other goods and services the recreationist could purchase with his income. The recreationist is again limited to a fixed budget, which imposes a constraint upon him. It is recognized that the recreationist also faces a time constraint and, in some cases, this may be more severe than his budget constraint. However, the time constraint is not considered explicitly in this analysis.

The income, y_o, allocated to the consumption of the two commodities must just equal the total amount spent for the recreation-days commodity, $p_1q_1 + k$, plus the total expenditures for the non-recreation-days commodity, p_2q_2:

$$y_o = p_1q_1 + k + p_2q_2 \qquad y_o, p_1, p_2 \geq 0; \qquad q_1, q_2, k > 0 \qquad (13)$$

Thus, the recreationist will maximize the Lagrangian function

$$V = U(q_1, q_2) + \lambda(y_o - p_1q_1 - k - p_2q_2) \qquad (14)$$

by consuming those amounts of q_1 and q_2 that satisfy the budget constraint and the following first-order condition:

$$\frac{\partial U}{\partial q_1} \bigg/ \frac{\partial U}{\partial q_2} = p_1/p_2 \qquad (15)$$

The consumer will consume recreation and non-recreation up to the point where the ratio of the marginal utilities associated with recreation and non-recreation is equal to the ratio of their respective prices.

The budget constraint can be rewritten as:

$$y_o - k = p_1q_1 + p_2q_2 \qquad (16)$$

Equation (16) more clearly illustrates the importance of k. It reduces the income available to the consumer for purchasing the commodities. It is assumed that k can be equal to zero if, and only if, no recreation is consumed:

$$k = 0 \iff q_1 = 0.$$

This assumption points out a unique characteristic of the budget constraint. If $k = 0$, the budget constraint takes on a new form:

$$y_o = p_2q_2 \qquad \text{for } y_o, p_2, \geq 0; \qquad q_2 > 0; \qquad k = 0 \qquad (17)$$

If faced with the budget constraint given in Equation (17), the consumer would maximize his utility by taking as many non-recreation units as his income would allow; he would consume $q_2 = y_o/p_2$ units of Q_2, and no units of recreation, Q_1.

Variations in Travel Cost (k)

The indifference map and budget constraints of a typical consumer are presented in Figure 9. The two prices, p_1 and p_2, and the level of income are held constant. The only variation in the budget constraints is due to changes in k. The budget constraint BC_o is one for which $k = k_o$, a large positive value. The point on the vertical axis at $q_2 = y_o/p_2^o$ illustrates the discontinuity in the budget constraint. If the consumer allocated all of his income to the consumption of non-recreation, he could attain the position y_o/p_2^o, since he will not have to withstand the additional travel cost required to enjoy recreation, as he must at all other points on budget line BC_o.

Given the set of indifference curves and the budget constraint BC_o in Figure 9, the consumer will prefer the combination $\{q_1 = 0, q_2 = y_o/p_2^o\}$ over any other attainable combination. He will enjoy a level of utility of U_1. If he chose any other attainable set of the commodities, he could attain only a level of utility of U_o.

If the travel cost were less than previously considered, say $k = k_1$, the consumer would be faced with the budget line BC_1 in Figure 9. Shifting the budget line to the right indicates the availability of more income to allocate to the two commodities; $k_o - k_1$ more dollars are available. Now the consumer, in maximizing his utility, has two alternatives: (1) he can take the combination $\{q_1 = 0, q_2 = y_o/p_2^o\}$, or (2) he can consume the set $\{q_1 = q_1^{(a)}, q_2 = q_2^{(a)}\}$. Either position provides a U_1 level of utility.

A further reduction in the travel costs would shift the budget constraint further to the right, as illustrated by BC_2 in Figure 9. The consumer now prefers to consume a combination of recreation and non-recreation. He will purchase $q_1^{(b)}$ units of recreation and $q_2^{(b)}$ units of non-recreation. He will attain a utility level of U_2.

Based on the theoretical concepts developed up to this point, recreationists will tend to spend fewer days at a site, per visit, as costs of travel increase. There is, however, a limit as to how high the travel costs can become, beyond which the consumer will not recreate. In Figure 9, when $k = k_1$, the consumer is indifferent between recreating and not recreating, while if $k < k_1$, he prefers to recreate a certain amount, depending on how much smaller k is than k_1. If $k > k_1$, the consumer would maximize his utility by not recreating, as when $k = k_o$. The travel cost of $k = k_1$ will be referred to as the "critical" travel cost, and will be denoted k^*. In this case,

$$k_1 = k^* \qquad \text{for } p_1 = p_1^o \tag{18}$$

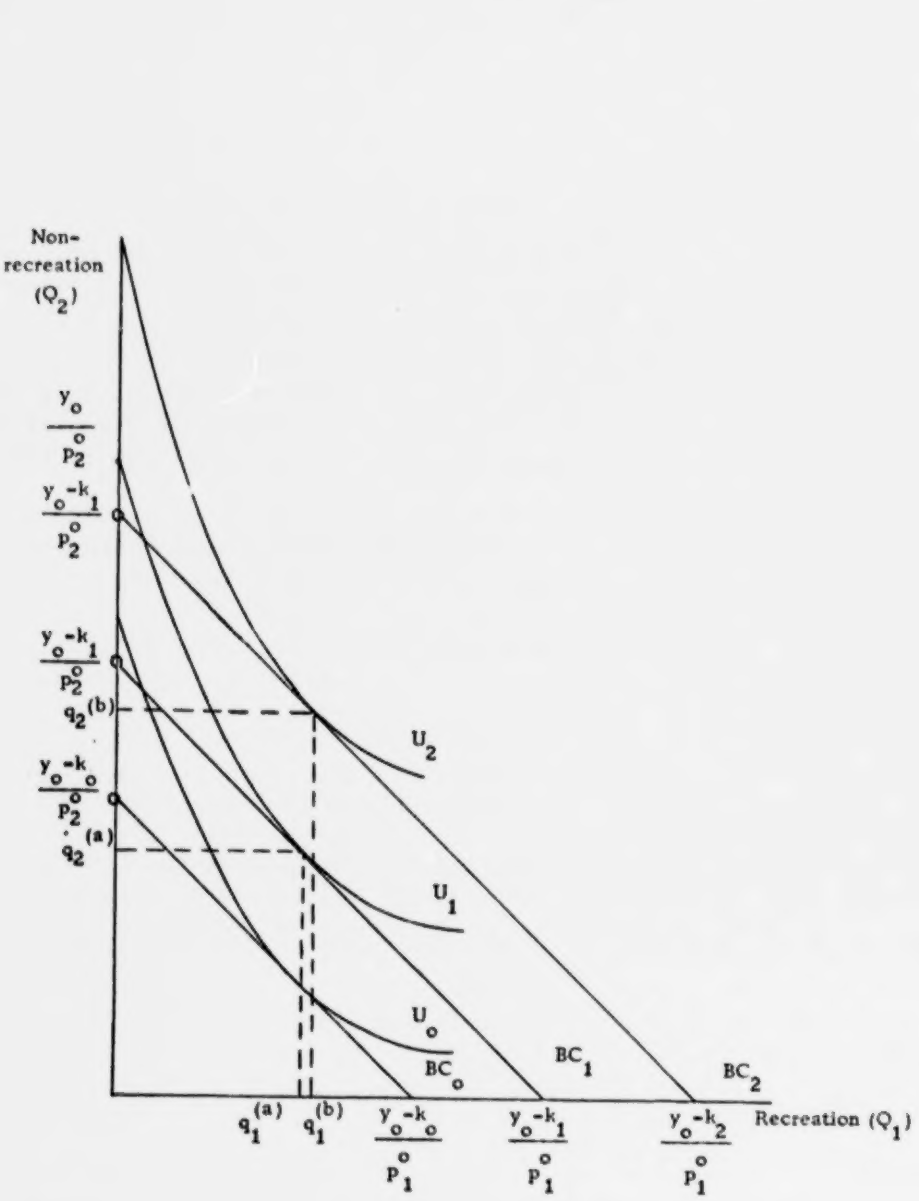
Non-recreation (Q_2)
$\frac{y_o}{p_2^o}$
$\frac{y_o-k_1}{p_2^o}$
$\frac{y_o-k_1}{p_2^o}$
$q_2^{(b)}$
$\frac{y_o-k_o}{p_2^o}$
$q_2^{(a)}$
U_2
U_1
U_o
BC_o
BC_1
BC_2
$q_1^{(a)}$
$q_1^{(b)}$
$\frac{y_o-k_o}{p_1^o}$
$\frac{y_o-k_1}{p_1^o}$
$\frac{y_o-k_2}{p_1^o}$
Recreation (Q_1)

Figure 9. The Optimal Combinations of Recreation and Non-Recreation Given Travel Costs of k_o, k_1, and k_2 for Given Prices p_1^o and p_2^o, and Fixed Income y_o.

The effect on the number of days of recreation demanded, per visit, is zero for decreases in k when:

$$k - \Delta k > k^*$$

That is, if the value of k decreases, but the resulting travel cost is still larger than the critical travel cost, k^*, the person will not recreate. For any decrease in k such that:

$$k - \Delta k < k^*$$

the effect on the quantity demanded for recreation will be the same as an increase in income. The effect on the amount of recreation consumed depends on how much smaller k is than k^*, that is, upon the size of $(k^* - k)$.

The value of the critical travel cost can be expressed as a function of four independent variables. k^* depends upon on-site costs, the cost of one unit of q_2, the level of income, and the utility function:

$$k^* = k^*(p_1, p_2, y, U) \qquad (19)$$

As p_1 or p_2 increase, the value of k^* will decrease, due to the fixed budget available: $\partial k^*/\partial p_1 < 0$, $\partial k^*/\partial p_2 < 0$. As the level of income increases, ceteris paribus, so will k^*; $\partial k^*/\partial y > 0$, due to the nature of recreation; that is, it is a normal good. The effect of U on k^* will be discussed later, in conjunction with the utility variable.

The conclusions drawn in this analysis hold for any system of indifference curves in which both commodities have positive marginal utilities and that possess the general shape consistent with maximization of utility, that is, they satisfy the first- and second-order conditions. The commodities Q_1 and Q_2 must be defined in such a way that the indifference curves intersect the q_2 axis, that is, it must be possible to have positive utility while consuming no Q_1.

Changes in On-Site Costs (p_1)

Changes in the relative prices of recreation and non-recreation commodities have a different effect on the demand for recreation, q_1, than did the travel cost considered above. A change in either of the prices, p_1 or p_2, will directly affect the optimal budget allocation of the consumer. The indifference map and budget constraints of an individual, similar to the one presented in Figure 9, may be analyzed analogously.

By varying the on-site costs, p_1, the resulting changes in q_1 can be observed, and a critical on-site cost, p_1^*, can be defined. The value of the critical on-site cost depends upon travel costs, the level of income, the price of other commodities, and the utility function:

$$p_1^* = p_1^*(k, y, p_2, U) \qquad (20)$$

The effect of k on p_1^* can be illustrated. As k increases, the critical price of recreation decreases, $\partial p_1^*/\partial k < 0$. On the other hand, as the level of income increases, it is expected that the value of the critical price would also increase, $\partial p_1^*/\partial y > 0$, due to the fact that recreation is a normal good. As the price of q_2 increases, the critical on-site costs will tend to decrease: $\partial p_1^*/\partial p_2 < 0$.

In general, for given conditions relating to preferences, income, and prices of other commodities, there exists a critical value of p_1 for every value of k, and a critical value of k for every value of p_1.

The model used in this study to determine how many days of recreation will be taken, per unit of time, can be written in three structural equations:

$$q_1 = q_1[(k^* - k), (p_1^* - p_1)] \tag{21}$$

$$k^* = k^*(p_1, p_2, y, U) \tag{22}$$

$$p_1^* = p_1^*(k, y, p_2, U) \tag{23}$$

In Equation (21) it is hypothesized that the quantity of recreation demanded per visit will increase as the difference between the travel cost and the critical travel cost become greater, and as the difference between on-site costs and critical on-site costs become greater:

$$\frac{\partial q}{\partial(k^* - k)} > 0 \text{ and } \frac{\partial q}{\partial(p_1^* - p_1)} > 0.$$

The empirical specification of this model will be discussed in the next section. The empirical content of each variable will be specified in order to determine the statistical model. Sampling procedures are also discussed.

SECTION V

EMPIRICAL SPECIFICATION OF THE MODEL

Some of the variables in the theoretical model cannot be measured directly. A good example is the utility function of the recreationists. Before the hypotheses developed in the previous section can be tested, a statistical model must be developed from the theoretical model. In this section, empirical implications of each variable in the theoretical model are discussed.

A general comment should be made before discussing specific variables. Several of the variables share a common property that cause measurement problems. The magnitudes of many recreational expenditures increase nearly proportionally to increases in the size of the recreational group. Examples are food, lodging, and other expenses related to individual consumption. To reduce the variation in the variables that is due to the size of the group, each variable is expressed on an individual basis. The expenses that a group incurred are divided by the number in the party.

A disadvantage of expressing the cost variables on an individual basis is that economies of size may be realized when they are not relevant. For example, automobile expenses remain nearly constant as the size of the group increases, as long as the number of autos does not increase. However, the average automobile cost per person would decrease as the size of the group increases. The low cost-per-person is considered unimportant in the decision making if the recreational group is a family unit, since all expenses are paid by the family.

The biases that are forthcoming as a result of expressing the variables on a per-person basis are not thought to be serious. It is believed that the economies of size bias are less serious than the biases which would be introduced by using group observations.

Discussion of the Variables

Days of Recreation per Visit (q_1)

The questionnaire used for data collection was designed to determine when the recreationist arrived at the site, and when he planned to leave. From this information, the number of days the recreationist stayed at the site can be determined.

Travel Cost (k)

The travel cost the recreationist incurs to recreate consists of the cost of transportation, food expenditures, lodging, camping fees, and any other expenses encountered while traveling to or from the recreational site. Some of these components will be studied separately.

> Cost of Transportation: The transportation cost is the amount it costs the recreationist to drive to and from the recreational site. This includes gasoline, oil, depreciation, insurance, repairs, and any other miscellaneous items involved with operating an automobile. These costs were not specified in the questionnaire. The transportation cost was computed by multiplying the total number of miles traveled, in both directions, by a cost-per-mile of five cents. The cost-per-mile figure was determined from previous studies as well as current research, in which recreationists were asked to enumerate their transportation costs [Guedry, 1970, and Stevens, 1966]. Although none were encountered in the study, other means of transportation can be accommodated in the model.
>
> Food: The recreationist who spends time away from home must make arrangements for his food consumption. He may prepare food at home to take with him, or purchase the ingredients at grocery stores to prepare along the way, or he may patronize restaurants and cafes. In any case, the recreationist may end up spending more, less, or the same amount of money for food while traveling as he would have spent if he had stayed home.
>
> The relevant food expenditure made by the recreationist is not the total amount spent for meals while traveling. The amount that he would have spent at home, had he chosen not to recreate, should be deducted from his food expenditures associated with the recreational visit. Information was not collected to determine how much the recreationist would spend for food while at home. However, U.S. Department of Agriculture data [1968, Table 2, p. 7] was adjusted to indicate the average daily food costs per person for various levels of income in 1967. The appropriate average expenditure for food at home was subtracted from the average expenditure per person for food while traveling. The difference, which, in some instances was negative, was added to the calculations of the travel cost variable. If no expenditure was made for meals while enroute, this adjustment was not made.
>
> Other Costs of Travel: The cost of lodging, camping fees, and any miscellaneous expenses while traveling were obtained in the personal interview.

On-Site Costs (p_1)

On-site costs are the total costs incurred by the recreationist per day while visiting the recreational site. They include the costs of lodging, camping fees, equipment rentals, meals, and other miscellaneous expenses incurred at the site. The total expenses that the recreational group incurred per day are divided by the number of persons in the group to obtain the daily on-site cost per person.

The daily food cost per person, while recreating at the site, is computed from information obtained in the interview. For reasons mentioned above, the average daily expenditure per person for food while at home, within the corresponding income groups, is subtracted from the calculated on-site food cost per person per day. The difference in the two figures, whether positive or negative, is used in the calculations to determine the p_1 variable. All of the remaining components of the on-site cost variable are accounted for in the questionnaire.

Income (y)

In this analysis the family income of the recreationist, after taxes, is used. The questionnaire was used to obtain data about the size of the recreationist's family, the age of the household head, and the gross family income. It was then possible, using a Federal Income Tax table, to estimate the amount of federal taxes paid in 1967. It was not feasible to estimate the amount of state taxes paid, since recreationists came to Oregon's lakes from several states. Thus, the income used in this analysis is biased upward. However, the error is not considered significant. Federal income taxes are usually much larger than state taxes. The majority of the relevant taxes have been subtracted.

Price of Other Commodities (p_2)

The price of other commodities, in theory, is equal to the weighted average of the prices of all other commodities that the consumer may choose to purchase:

$$p_2 = \alpha_1 p_3 + \alpha_2 p_4 + \cdots + \alpha_{n-2} p_n$$

where p_i is the price of the i^{th} commodity, and α is the weighting factor of the i^{th} commodity. In practice, however, the commodities that comprise the alternatives to recreation are so numerous and so diverse among individuals that it is impossible to specify them. Therefore, the p_2 variable was deleted from the statistical model.

Utility (U)

The utility variable in Equations (22) and (23) is important in determining the critical values of travel cost and on-site costs. A change in the shape of the indifference curves, through a change in the utility function, will cause a change in k^* and p_1^*. Unfortunately, the utility function is not measureable. However, it can be represented, in part, by several other variables. Some of the variables considered important in this respect are the characteristics of the recreationist, the characteristics of the site, and the value of recreational equipment.

Characteristics of the Recreationist: The recreationist's characteristics influence his decisions concerning the consumption of recreation. The background of the person, his stage in the family cycle, his age, and so on, influence his utility function. However, with the exception of income, these personal characteristics of recreationists were not taken into account in this study. In another study conducted at Oregon State University, Guedry [1970] specified the relationship between the characteristics of the individual recreationist and the demand for recreation.

Site Characteristics: Recreationists choose a site because of the "desirability" of its characteristics. If a study is conducted to determine the recreational use and value of a particular site, and information is gathered only at that site, the characteristics of the site are fixed and do not need to be analyzed explicitly. However, if data are collected at more than one site, and each of the sites has different characteristics, the characteristics may explain the variation in quantity of recreation days observed at the sites, and the characteristics that are desirable to recreationists could be identified. Determination of the characteristics that have a substantial effect upon the use and value of the site can help decision makers plan site alterations to gain the user benefits from favorable characteristics.

The specific site characteristics of interest in this study are the size of the lake (measured in acres), and the level of use of each lake for various recreational activities. The activities considered are swimming, boating, water skiing, fishing, and camping. Discrete values were used to indicate the amount each of the lakes was used for each activity. If an activity was non-existent at a lake, it was given the value of zero. Low, medium, and high uses of the lake for a given activity were assigned the values one, two, and three, respectively. The use-intensities were estimated by U.S. Forest Service personnel and employees of the E.P.A. who were knowledgeable about the lakes' characteristics. It is recognized that the values are subjective. Table 1 contains the estimated use-intensities for each activity at each lake in the study area. The selection of the four lakes used in the study will be discussed later in this section.

Investment in Recreational Equipment: It is hypothesized that the value of recreational equipment owned by the individual may serve as a proxy for a person's utility function with respect to recreation. An individual with

Table 1. Estimated Use-Intensities for Certain Recreational Activities and Lake Size, by Lake

Lake	Use-Intensities					Lake size
	Swimming	Water skiing	Boating	Fishing	Camping, picnicking	
						(acres)
Lake of the Woods....	3	3	3	1	3	1,055
Odell................	0	0	1	3	2	3,500
Willow...............	1	1	1	3	2	320
Klamath..............	0	1	1	1	0	98,560

a large quantity of recreational equipment, such as boats, campers, trailers, and so forth, probably has a stronger preference for recreation than a person with less equipment. A qualification is necessary, however. This phenomenon would be expected to be observed only when a comparison is made among similar activities. Wilderness-type activities cannot be compared to those at a more accessible site, since each requires a unique combination of equipment.

Investment in recreational equipment may also be a useful substitute for income as an explanatory variable. Two reasons seem apparent. First, investment is more correlated with the permanent income of the recreationist than with current annual income. This is important, since permanent income is considered more closely associated with the quantity of recreation taken than is current income. A case in point is a retired person. He may have a low current income, but the amount of equipment he owns is related to his previous permanent income. On the other hand, a young person beginning his career probably purchases equipment with the future in mind. Even though he may have a low current income, it may be his expected permanent income that determines his purchases of equipment.

There is another closely related reason why the amount of recreational equipment may be more useful as an explanatory variable than is current income. While the recreationist's income stream may be stable over time, his expenditures for items other than recreation may fluctuate widely. These fluctuations may be due to the "lumpiness" of certain household expenditures, as well as to the occurrence of events in a person's life which necessitate unusually high expenditures during a given period for which no plans had been made. Cash outlays for outdoor recreation during any one period may be subject to these fluctuations in expenditures for other commodities. On the other hand, the consumer's investment in outdoor recreational equipment may reflect more nearly his long-run budgeting plans.

The Statistical Model

The statistical model, when more than one site is analyzed, is:

$$q_1 = q_1[(k^* - k), (p_1^* - p_1)] \quad \text{for } (k^* - k), (p_1^* - p_1) \geq 0 \tag{24}$$

$$k^* = k^*(p_1, y, Sw, Ws, B, F, C, I, Si) \tag{25}$$

$$p_1^* = p_1^*(k, y, Sw, Ws, B, F, C, I, Si) \tag{26}$$

where Sw, Ws, B, F, and C represent the site's use-intensity for swimming, water skiing, boating, fishing, and camping, respectively. I indicates the value of recreational equipment and Si indicates the size of the lake, in acres. All other variables are as defined above.

The demand function of interest in the study is the aggregate demand function for the total number of visitor-days per season. The preceding model is appropriate for explaining the number of visitor-days per visit. That is, it pertains to an individual, not to the population of users. The total number of visitor-days can be obtained by multiplying Equation (24) by the estimated number of visits (V) to the site during the season. The appropriate aggregate model is:

$$Vq_1 = f[(k^* - k), (p_1^* - p_1)] \qquad \text{for } (k^* - k), (p_1^* - p_1) \geq 0 \tag{27}$$

$$k^* = k^*(p_1, y, Sw, Ws, B, F, C, I, Si) \tag{28}$$

$$p_1^* = p_1^*(k, y, Sw, Ws, B, F, C, I, Si) \tag{29}$$

where V indicates the number of visits to the site during the season. The total number of visits at each site during the relevant season was obtained from the U.S. Forest Service, since the lakes studied had facilities maintained by the Forest Service.

The Number of Visits Relationship

One other relationship must be discussed. The aggregate demand model contains the V variable, which represents the number of visits to the site. This variable can be estimated in two possible ways.

The first approach is to use the estimates of the number of visits reported by the U.S. Forest Service, and have it remain fixed with respect to any changes in the independent variables in the model. The second method is to use the estimated number of visits, as above, but then express V as a function of some appropriate explanatory variables. In this way, when a postulated change occurs in the independent variables, the effect upon the number of visits, as well as upon the length of stay per visit, can be observed. The second approach gives a more meaningful estimate of the total number of visitor-days.

In line with the second approach, it is hypothesized that the number of visits forthcoming at a site for an individual can be expressed as a function of the travel cost, the income of the recreationist, and the characteristics of the site. Information was not obtained from recreationists to determine the number of visits they would make during the season. Thus, it is impossible to focus attention on the individual recreationist. An alternative does exist, however. The total estimated visits, V, can be allocated to regional population groups, and the relationship between the number of visits from the i^{th} region and the explanatory variables can be computed. It is hypothesized that the number of visits forthcoming from an area, V, is functionally related to the average travel cost, k, of recreationists residing in the area, the

the average income of recreationists from the area, y, the total number of persons living in the area, pop, and the characteristics of the site under consideration:

$$V = V(k, y, pop, Sw, Ws, B, F, C, Si) \qquad (30)$$

Sampling Procedures

To estimate the statistical demand model, primary data had to be gathered from recreationists. Since the primary objective of the study is to estimate the recreational use of Klamath Lake with improved water quality, it is necessary to collect the data at lakes that have different characteristics. By observing the various characteristics of these lakes and the intensity of each lake's use, it is possible to predict the increase in use of Klamath Lake as its characteristics, such as water quality, improve.

Three lakes, in addition to Klamath Lake, were chosen for the data collection process. They are Odell Lake, Lake of the Woods, and Willow Lake. These lakes were chosen for several reasons. First, many of the recreationists living in the Klamath Falls area are now using the three lakes, or other lakes in the vicinity of these lakes, for recreation. Also, these lakes possess many of the characteristics, such as the size and the water recreation activities, that are of interest in this study. Only lakes that were easily accessible and had overnight facilities were considered, since these attributes were deemed a necessity for the average recreationist to consider substituting that lake for Klamath Lake.

For sampling purposes the population was defined as the total number of recreationists that visited the four lakes during 1968. The sampling unit is the recreation unit; that is, the group that recreates together.

The appropriate sampling frame would be a list of all the recreation units found in the area of study in 1968. Of course, such a listing is impossible to obtain. Therefore, stratified random sampling techniques were used to obtain the sample.

First, standard statistical methods were used to estimate the sample size necessary to obtain the precision desired for the study. A sample size of 300 was estimated. A complete discussion of the estimation of the sample size is contained in Gibbs [1969].

The total sample of 300 was then allocated to the four lakes on the basis of the estimated number of recreation days taken at each lake. Data available from the U.S. Forest Service and other agencies provided estimates of the number of recreation-days taken at each of the four lakes in 1967. These were summed to obtain the total number of recreation-days taken at all four lakes. If a lake accounted for 30 percent of the total recreation-days, 30 percent of the sample size of 300 was allocated to that lake, and so forth.

The area immediately surrounding each lake was also divided into several geographic blocks. For example, all camping areas, boat ramps, picnic areas, lodges, cabins, etc., were placed in separate blocks. The sample size allocated to each lake was again distributed to the various geographic blocks on the basis of frequency-of-use of each of the blocks. The same procedure was used at each of the four lakes.

The proper time to conduct the interviews also had to be determined. To accomplish this, all possible weeks in the summer season were numbered, and two weeks were chosen randomly. The total number of interviews needed at each block at each lake was divided equally between the two weeks. Estimates were then obtained from the appropriate agencies as to the relative use of the lakes during the week and weekends. The sample was then allocated by this factor. If twice as many people recreated on weekends as during the week, two-thirds of the sample data were collected on the weekend. Table 2 shows the final distribution of the sample among the sites, weeks and days for each lake.

The recreationists within each block at each lake were then selected at random to be interviewed. Care was taken that the sample was representative of the activities at the site. That is, if approximately two-thirds of the people at a site were picnicking, and one-third were water skiing, the sample contained twice as many picnickers as water skiiers. Care was also taken to prevent interviewing recreationists on the basis of the type or amount of equipment they were using. The questionnaire used in the study is included in Appendix A.

Table 2. Number of Interviews Taken at Each Lake, by Block, for the Four Time Periods.

Lake	Block	First Week Week days	First Week Week end	Total	Second Week Week days	Second Week Week end	Total	Two-week total
KLAMATH:	Recreation Creek.......	1	2	3	1	2	3	6
	Odessa.................	0	1	1	0	0	0	1
	Rocky Point Resort.....	3	11	14	3	11	14	28
	Moore Park.............	2	7	9	2	6	8	17
	Pelican Marina.........	0	1	1	0	1	1	2
	Yacht Club.............	0	1	1	0	1	1	2
	Public Boat Launch & Bank Fishermen.....	0	0	0	0	1	1	1
	TOTAL KLAMATH LAKE.....	6	23	29	6	22	28	57
LAKE OF THE WOODS:	Rainbow Bay............	5	17	22	5	17	22	44
	Aspen Point............	3	13	16	3	12	15	31
	White Pine.............	0	2	2	0	2	2	4
	Lake of the Woods Resort..............	3	11	14	3	10	13	27
	TOTAL LAKE OF THE WOODS	11	43	54	11	41	52	106
ODELL:	Princess Creek.........	6	7	13	6	7	13	26
	Sunset Cove............	3	3	6	2	3	5	11
	Trapper Creek..........	10	11	21	11	10	21	42
	Pebble Bay.............	0	0	0	0	0	0	0
	Odell Creek............	1	2	3	1	1	2	5
	Odell Summit Lodge.....	1	2	3	1	1	2	5
	Odell Lake Resort......	1	1	2	1	1	2	4
	Shelter Cove Marina....	0	1	1	0	1	1	2
	TOTAL ODELL LAKE.......	22	27	49	22	24	46	95
WILLOW:	County Campground......	5	16	21	5	16	21	42
	TOTAL..................	44	109	153	44	103	147	300

SECTION VI

ESTIMATING AND APPLYING THE STATISTICAL DEMAND MODEL

The data collected from recreationists at the four lakes in the study area are used to estimate the equations of the hypothesized statistical demand model. Four relationships are estimated. They are: p_1^*, the critical on-site cost relationship; k^*, the critical travel cost relationship; q_1, the demand relationship; and V, the number of visits relationship.

Before each of the relationships are discussed, a problem which was encountered in three of the equations will be discussed. When the equations for critical travel cost, critical on-site cost, and the number of visits were estimated, multicollinearity was observed among the site characteristic variables of swimming, water skiing, and boating use-intensities. When one of the three use-intensity variables entered into the regression equation, neither of the other two variables could explain enough additional variation in the dependent variable to be significant. Since the simple correlation coefficients between the three variables ranged from .957 to .980, it was not possible to estimate the separate influence of each of the three variables. Consequently, the three variables were combined into one variable. The use-intensity rankings for swimming, water skiing, and boating were summed to represent a single variable for each lake, denoted as W.

Another case of multicollinearity was observed between the camping intensity variable and income. This was considered to be a statistical problem with no economic significance. Because of their differing nature, it was not feasible to combine the two variables. Instead, the camping intensity variable was deleted from the model, since camping intensity may be more closely related to the man-made characteristics of the site than the natural characteristics being considered in this study.

Statistical problems also prevent the use of the recreational equipment variable (I) in the study. The problems can be illustrated by discussing the work of Guedry [1970]. In his equation to determine the number of recreation days taken, per capita, in the Bend Ranger District in Oregon, the "investment in recreational equipment" variable was significant at the 2 percent level. However, the sign of the coefficient was negative. The negative sign is somewhat confusing, since it suggests that the average length of stay at the recreational site decreases as the amount of investment in recreational equipment increases. This is opposite from the effect that one would expect. To determine a reason for this, all variables in the equation that had a simple correlation coefficient greater than or equal to .7 with the recreational equipment variable were removed, and a new equation was estimated. The new partial regression coefficient for the equipment variable in the new equation was significant only at the 50 percent level.

In a further attempt to clarify the problem, Guedry removed all variables with a simple correlation coefficient greater than or equal to .6 with the equipment variable. A new equation was then estimated, and the partial regression coefficient of the recreational equipment variable was significant at the 10 percent level, and the sign of the coefficient was positive. The erratic performance of the recreational equipment variable makes it difficult to form any conclusions as to its role in the demand equation. Since the same type of problems were experienced in this study, investment in recreational equipment is omitted as an explanatory variable. The variable appears to be too highly correlated with other variables in the model to be of significant value.

The above changes leave the statistical model to be estimated as:

$$q_1 = q_1[(k^* - k), (p_1^* - p_1)] \quad \text{for } (k^* - k) \text{ and } (p_1^* - p_1) \geq 0 \tag{31}$$

$$p_1^* = p_1^*(k, y, W, F, Si) \tag{32}$$

$$k^* = k^*(p_1, y, W, F, Si) \tag{33}$$

$$V = V(k, y, pop, W, F, Si) \tag{34}$$

Each relationship will be discussed below.

Critical On-Site Cost Relationship

Critical on-site cost is related to travel cost, level of income, and site characteristics. Since the estimation procedure is performed on more than one recreational site, the observations were categorized by sites, and placed in homogeneous groups determined by income level and travel costs. The income groups were determined as follows: the incomes of all recreationists were listed in descending order of magnitude. Consideration was given to the "natural" breaks in the list; but, due to the small number of observations, only two cutoff points were chosen. The cutoff points were chosen to ensure that each group would have approximately the same number of observations. For all lakes, the three income groups are: (1) less than or equal to \$8,000, (2) between \$8,000 and \$10,000, and (3) greater than or equal to \$10,000.

The distribution of travel costs is different for each lake. For this reason the groups were determined individually for each lake. The cutoff points for Klamath Lake are \$1 and \$19. That is, the three groups are: (1) less than or equal to \$1, (2) between \$1 and \$19, and (3) greater than or equal to \$19. For Lake of the Woods, the cutoff points for k are \$2 and \$20; for Odell Lake, \$5 and \$10; and for Willow Lake, \$2 and \$10.

To estimate the maximum p_1 within each subgroup, determined by income and travel costs, the variable on-site costs in each subgroup were arranged in ascending order of magnitude. The last (or n^{th}) p_1 is the maximum p_1 observed in the subgroup, and is referred to as the n^{th} order statistic. The n^{th} order statistic is used as a reliable estimate of the maximum p_1 in the distribution [Hogg and Craig, 1965, ch. 6]. The use of the maximum observed p_1 as an estimator of p_1^* does not imply that all other p_1's are ignored. The maximum p_1 is chosen only after it has been compared to all other p_1's in the subgroup. Thus, all the sample information is used.

As a result of the above classification technique, the number of observations varies in each subgroup. The reliability of the estimate of p_1^* depends upon the number of observations in the subgroup. Reliability refers to the size of the variance. If the variance is large, the estimator is less reliable. In utilizing regression analysis, it is assumed that the diagonal elements in the variance-covariance matrix are constant, or nearly so. In this case, the p_1^*'s of some subgroups have higher variances than others; thus, the constancy of variances assumption is violated. The coefficients estimated by ignoring this type of problem will be unbiased, but will not have minimum variances. It is necessary, then, to make adjustments in the analysis to ensure unbiased, minimum variance estimators. Weighted least squares was used to correct the problem. The technique involves assigning larger weights to the reliable estimates than to the unreliable ones [Draper and Smith, 1966]. The weights are equal to the square root of the number of observations in the subgroup.

The level of income and the travel cost, from each subgroup, are used as observations and are then regressed on the resulting p_1^*'s (for each subgroup) to obtain an estimate of the relationship between the independent variables and p_1^*. The critical on-site cost relationship estimated by weighted least squares is:

$$
\begin{aligned}
p_1^* = -7.263 &+ \underset{(.197)}{7.80\, W^{\#\#\#}} + \underset{(.815)}{2.630\, F^{\#\#\#}} + \underset{(.000025)}{.000067\, Si^{\#\#}} - \underset{(.002)}{.004\, k^{2\#}} \\
&+ \underset{(.143)}{.269\, k^*} + \underset{(.0000000094)}{.000000017\, y^{2\#}} \qquad R^2 = .684^{\#\#\#} \\
&\qquad\qquad\qquad\qquad\qquad\qquad \text{Degrees of freedom} = 27 \qquad (35)
\end{aligned}
$$

where W, F, and Si are the site characteristic variables, as previously defined, k is the average travel cost of the subgroup, and y is the average income for the subgroup. The standard error of the coefficients is shown in parentheses below the coefficients. Each coefficient was tested to determine if it was significantly different from zero. The test is made by dividing the coefficient by its standard error and comparing the resulting value with the values in a student's t table. A 1 percent level of significance is referred to by ###, a 5 percent level of significance by ##, and # indicates the coefficient is significant at the 10 percent level. If no marks are listed, the coefficient is sufficiently different from zero at a level of probability greater than 10 percent.

Only two variables, W, and F, are significantly different from zero at the 1 percent level. The size of the lake variable is significant at the 5 percent level, while travel cost, travel cost squared, and income squared are all significant at the 10 percent level.

It was hypothesized that the site characteristics should have a positive effect on the critical on-site costs. The obtained results are consistent with this hypothesis. The conceptual framework of this study also suggested a negative relationship between travel cost and critical on-site costs. Equation (35), however, indicates that the relationship is positive. The analysis suggests that as travel costs increase, the critical on-site costs will also increase, but at a decreasing rate, since the k-coefficient is positive but the k^2 coefficient is negative.

Income has, as was hypothesized, a positive influence on p_1^*. The reliability of this relationship is not high, since the coefficient is significant only at the 10 percent level. The evidence indicates, however, that as income increases, the critical on-site costs will increase at an increasing rate. The difficulties of defining and obtaining data for the appropriate income variable were discussed earlier. Perhaps these explain the failure of the empirical model to produce a statistically more significant result with respect to the income variable.

The R^2 for the critical on-site cost equation is .684, which is significant at the 1 percent level.

From the estimated equation it is possible to see the predicted effect on p_1^* of changing the characteristics of the site. For example, if fishing intensity were to increase one unit, perhaps due to a change in the water quality, the recreationist would be willing to increase the maximum willingness to pay at the site by \$2.63 per day.

Critical Travel Cost Relationship

The critical travel costs, k^*'s, were also estimated by using the n^{th} order statistic after the observations had been separated into subgroups on the basis of lakes, income, and on-site costs. The income groups are the same as those used in the critical on-site cost relationship, while the subgroups defined by p_1, for all lakes, are: (1) $\leq$ \$1.50, (2) between \$1.50 and \$2.50, and (3) $\geq$ \$2.50. Average values of income and on-site costs were determined for each group. The predicted k^* equation is:

$$k^* = -36.711 + \underset{(2.322)}{6.248\, W^{\#\#}} + \underset{(7.800)}{3.779\, F} + \underset{(.0002)}{.0003\, Si} + \underset{(.0018)}{.0020\, y} \tag{36}$$

$$+ \underset{(3.349)}{10.435\, p_1^{\#\#\#}} \qquad R^2 = .616^{\#\#\#} \quad \text{Degrees of freedom} = 28$$

In Equation (36) only the on-site costs variable is significant at the 1 percent level, while the "water" variable, W, is significant at the

5 percent level. All other variables fail to obtain the 10 percent level of significance.

It was hypothesized that the characteristics of the site have a positive effect on k^*. That is, as the characteristics of the site improved, recreationists would be willing to pay more in travel costs. The sample data supports this hypothesis, since the W, F, and Si variables are all positive. However, due to the low significance of the fishing intensity and the lake size variables, few conclusions can be stated with much reliability concerning the existence of a relationship between these variables and k^*.

The sample data also suggests a positive relationship between income and critical travel costs. This had been hypothesized. Again, however, the low level of significance of the income coefficient makes it impossible to place much reliability upon the relationship.

The lack of significance of the income variable may be due, in part, to the broad income groups used to estimate k^*. Since only three income groups were used, the income range within each group was quite large. More data would have made it possible to define smaller ranges of income. Then the variation in income, and its effect upon k^*, could have been more clearly observed.

On-site costs, statistically the most significant variable in the equation, exhibits a positive relationship with k^*. However, the theory suggested that as a person was required to spend more at a recreational site, he would be willing to pay less in travel costs, due to his fixed budget. This hypothesis is rejected by the sample data. Possible explanations may include the fact that on-site costs usually comprise a much smaller portion of the recreationist's budget than do travel costs. Because of this, other effects may be more important in the decision-making. For example, in this study the more desirable sites may have a higher daily on-site cost. Recreationists may be willing to pay higher travel costs to visit the more desirable site, even if on-site costs are slightly higher.

The coefficient of determination, R^2, for the k^* equation, is .616. It is significantly different from zero at the 1 percent level.

Days Per Visit Relationship

The above discussion refers to the estimation of the k^* and p_1^* values. Each questionnaire contains data that made it possible to compute the length of stay per visit, q_1, the actual travel cost, k, and the actual on-site cost, p_1. Therefore, the independent variables for the q_1 equation, $(p_1^* - p_1)$ and $(k^* - k)$, are obtained by subtracting the observed p_1 and k values from the appropriate group's p_1^* and k^* values.

Since 304 observations were collected, there are 304 possible sets of values of $(p_1^* - p_1)$ and $(k^* - k)$ to use in the regression equation. However, two distinct groups of recreationists were observed in the sample. One group was characterized by spending less than three weeks at the site and having relatively high values of $(p_1^* - p_1)$. The other (much smaller) group spent a longer time at the site (up to 169 days) and had relatively low values of $(p_1^* - p_1)$. This group included retired people spending most of the season at the site, and persons such as teachers, who did not have summer job commitments.

Further analysis of the recreationists in the second group revealed that they did not respond significantly to changes in p_1 and k. That is, there was no relationship between the length of stay per visit and the $(p_1^* - p_1)$ and $(k^* - k)$ variables. Therefore, the group of recreationists that stayed at the site 20 days or more was not used to estimate the q_1 equation. The remaining 282 observations were used to estimate the following q_1 relationship:

$$\ln q_1 = .759 - \underset{(.0018)}{.0064}\,(k^* - k)^{\#\#\#} + \underset{(.0189)}{.0637}\,(p_1^* - p_1)^{\#\#\#} \qquad (37)$$

$R^2 = .113^{\#\#\#}$
Degrees of freedom = 279

The average length of stay per visit for recreationists in this group is 3.4 days.

It was hypothesized that as the difference between the critical travel cost and the actual travel cost increased, the number of days the recreationist would remain at the site per visit would also increase. In Equation (37) a negative coefficient is estimated which is significant at the 1 percent level. In other words, evidence suggests that, for a given critical travel cost, as a person's actual travel costs increase, he will tend to recreate more days per visit. As was mentioned earlier, the appropriate income in the budget constraint depicted in the theory is (y - k). As k increases, less income is available to be spent at the site after arrival - thus fewer days will be forthcoming. Apparently travel costs are so small, relative to income, that they do not significantly reduce the income available for expenses at the site.

It was also hypothesized that as the daily on-site costs increased, given a fixed p_1^*, fewer days per visit would be observed. This hypothesis is substantiated by the analysis. The $(p_1^* - p_1)$ variable is significant at the 1 percent level.

The R^2 for Equation (37) is .113, which is significant at the 1 percent level. The R^2 is low; yet it must be remembered that in contrast to the previous equations, the number of observations is very large.

The Number of Visits Relationship

Counties were used to represent the regions in the visits equation discussed earlier. Information in the questionnaire indicates the county in which the recreationists resided. Record was made of the number of recreationists that originated from each county. These were expressed as a percent of the total sample compiled at each lake, and then multiplied by the estimated total visits for the season to estimate the number of visits from each county for the season.

The travel cost and income of all persons in the sample from each county had to be averaged to obtain average values for the regions. The population of each county was determined from the U.S. Bureau of the Census Population Estimates, 1966. The relevant counties, the population of the counties, as well as the information on visits, travel cost, and income, are listed in Table 3. Each lake is listed separately. It should be noted that the recreationists in the sample came from only four states: Oregon, California, Nevada, and Idaho. The sampled lakes are not well known outside the State of Oregon.

All of the data collected at the four lakes are used to estimate the visits relationship. For each of the counties observed at Klamath Lake, for example, the values assigned to the characteristics of Klamath Lake are used, along with the values of the other independent variables for that county group. There are data from 12 counties for Klamath Lake, 27 counties for Lake of the Woods, 29 for Odell Lake, and 9 for Willow Lake. Thus, 77 observations are available.

Since the independent variables k and y were aggregated within each county, some were more reliable than others, due to the number of observations within each county. Weighted least squares, similar to that discussed for determining the p_1^* and k^* relationships, was used to correct this problem. The estimated visits equation is:

$$V = -67{,}947.046 + \underset{(842.177)}{7{,}312.442\ W^{\#\#\#}} + \underset{(2{,}366.595)}{21{,}024.198\ F^{\#\#\#}} \qquad (38)$$

$$+ \underset{(.068)}{.648\ Si^{\#\#\#}} - \underset{(167.595)}{149.953\ k} - \underset{(.824)}{.118\ y} - \underset{(.0019)}{.003\ pop^{\#}}$$

$R^2 = .874^{\#\#\#}$

Degree of freedom = 70.

The site characteristics, referred to by W, F, and Si, are as defined earlier; k refers to the average travel cost of recreationists from each county; y represents the average income of recreationists from each county; and pop refers to the total population of each county.

It should be noted that the visits equation is redundant if one is not interested in changing some of the independent variables and predicting a change in total visitor-days. That is, if no changes are considered,

Table 3. The Population, Number of Sample Visits, Percent of Sample Visits, Visits per Season, Travel Cost, and Income, by County, for each of the Four Lakes

	KLAMATH LAKE					
County	Population of county (pop)	Sample visits	Percent of sample from each county	Visits (V)	Average travel cost (k)	Average income (y)
					(dollars)	(dollars)
Oregon:						
Deschutes...........	27,600	1	2.1	3,070	4.67	18,372
Jackson.............	91,300	5	10.4	15,205	2.16	7,547
Josephine...........	37,000	2	4.2	6,140	3.83	10,329
Klamath.............	49,600	29	60.4	88,305	0.26	8,385
Lane................	200,700	1	2.1	3,070	4.70	3,956
Multnomah...........	534,900	2	4.2	6,140	51.33	5,342
Washington..........	126,100	1	2.1	3,070	80.32	3,860
California:						
Orange..............	1,171,400	1	2.1	3,070	28.63	13,440
Los Angeles.........	6,814,500	3	6.3	9,211	80.26	13,355
San Bernardino.......	628,900	1	2.1	3,070	119.39	5,228
Santa Clara..........	929,800	1	2.1	3,070	19.29	15,315
Trinity.............	8,200	1	2.1	3,070	63.17	7,414
TOTAL.......		48	100.2	146,491		

Continued

Table 3. (Continued)

County	LAKE OF THE WOODS					
	Population of county (pop)	Sample visits	Percent of sample from each county	Visits (V)	Average travel cost (k)	Average income (y)
					(dollars)	(dollars)
Oregon:						
Coos	54,100	1	.8	2,130	14.36	7,528
Deschutes	27,600	1	.8	2,130	9.17	12,048
Douglas	72,600	2	1.6	4,260	11.51	7,131
Jackson	91,300	46	36.2	96,388	1.80	10,471
Josephine	37,000	6	4.7	12,515	.78	10,589
Klamath	49,600	19	15.0	39,940	2.84	8,327
Lane	200,700	2	1.6	4,260	8.66	10,335
Lincoln	25,500	1	.8	2,130	91.30	10,746
Linn	65,600	2	1.6	4,260	9.96	11,850
Multnomah	534,900	2	1.6	4,260	4.58	12,506
California:						
San Francisco	714,600	2	1.6	4.260	58.63	13,106
Monterey	229,900	3	2.4	6,390	50.86	7,057
Contra Costa	514,400	1	.8	2,130	79.38	13,740
Orange	1,171,400	3	2.4	6,390	33.85	10,790
Alameda	1,030,400	4	3.1	8,254	36.71	15,570
Los Angeles	6,814,500	10	7.9	21,035	54.78	14,942
Humboldt	101,300	1	.8	2,130	6.48	10,215
Santa Barbara	253,400	1	.8	2,130	19.20	5,646
Siskiyou	35,000	3	2.4	6,390	3.92	11,893
San Mateo	519,100	1	.8	2,130	17.01	11,010
San Bernardino	628,900	1	.8	2,130	26.76	13,440
Santa Clara	929,800	9	7.1	18,905	28.92	15,412
San Joaquin	283,500	1	.8	2,130	35.28	11,010
Sacramento	597,700	2	1.6	4,260	26.20	6,492
Del Norte	16,700	1	.8	2,130	9.10	7,414

Continued

Table 3. (Continued)

County	LAKE OF THE WOODS (Continued)					
	Population of county (pop)	Sample visits	Percent of sample from each county	Visits (V)	Average travel cost (k)	Average income (y)
					(dollars)	(dollars)
Nevada:						
Clark..................	233,700	1	.8	2,130	46.22	13,590
Idaho:						
Canyon................	60,400	1	.8	2,130	8.68	10,620
TOTAL......		127	100.4	267,327		

Continued

Table 3. (Continued)

County	ODELL LAKE					
	Population of county (pop)	Sample visits	Percent of sample from each county	Visits (V)	Average travel cost (k)	Average income (y)
					(dollars)	(dollars)
Oregon:						
Benton	49,100	3	3.1	5,595	6.45	8,318
Clackamas	146,100	4	4.1	7,400	7.22	5,259
Coos	54,100	2	2.1	3,790	11.29	5,280
Crook	10,100	1	1.0	1,805	3.87	7,414
Deschutes	27,600	2	2.1	3,790	12.14	5,373
Douglas	72,600	2	2.1	3,790	2.40	7,748
Jackson	91,300	3	3.1	5,595	8.17	11,194
Klamath	49,600	4	4.1	7,400	2.32	6,822
Lane	200,700	30	30.9	55,769	4.66	7,256
Lincoln	25,500	3	3.1	5,595	6.45	11,804
Linn	65,600	1	1.0	1,805	5.00	8,472
Marion	141,700	5	5.2	9,385	7.67	6,688
Multnomah	534,900	7	7.2	12,995	9.86	11,747
Polk	30,900	2	2.1	3,790	10.58	9,005
Washington	126,100	4	4.1	7,400	11.77	12,567
California:						
Contra Costa	514,400	2	2.1	3,790	23.11	8,669
Orange	1,171,400	1	1.0	1,805	44.53	18,540
Alameda	1,030,400	2	2.1	3,790	44.04	6,940
Los Angeles	6,814,500	6	6.2	11,190	28.79	15,502
Shasta	75,500	1	1.0	1,805	12.37	11,784
Siskiyou	35,000	1	1.0	1,805	15.09	7,114
San Mateo	519,100	1	1.0	1,805	12.87	12,048
Santa Clara	929,800	3	3.1	5,595	29.44	11,826
Modoc	7,500	1	1.0	1,805	10.05	9,519
Kern	325,200	1	1.0	1,805	24.97	10,746

Continued

Table 3. (Continued)

County	ODELL LAKE (Continued)					
	Population of county (pop)	Sample visits	Percent of sample from each county	Visits (V)	Average travel cost (k)	Average income (y)
					(dollars)	(dollars)
California (Continued):						
Marin................	188,600	1	1.0	1,805	11.72	21,804
San Diego............	1,188,000	2	2.1	3,7[illegible]0	40.36	8,330
San Joaquin..........	283,500	1	1.0	1,805	8.39	15,615
Sonoma...............	193,700	1	1.0	1,805	26.59	1,750
TOTAL.......		97	99.8	180,304		

Continued

Table 3. (Continued)

County	WILLOW LAKE Population of county (pop)	Sample visits	Percent of sample from each county	Visits (V)	Average travel cost (k)	Average income (y)
					(dollars)	(dollars)
Oregon:						
Douglas..............	72,600	1	3.1	3,397	2.77	6,700
Jackson..............	91,300	17	53.1	58,187	1.90	8,127
Josephine............	37,000	3	9.4	10,301	1.94	9,589
Klamath..............	49,600	1	3.1	3,397	2.30	8,586
Lane.................	200,700	1	3.1	3,397	8.65	7,870
Lincoln..............	25,500	1	3.1	3,397	28.53	10,614
Marion...............	141,700	1	3.1	3,397	14.53	1,750
California:						
Los Angeles..........	6,814,500	5	15.6	17,094	78.60	6,299
Siskiyou.............	35,000	2	6.3	6,904	9.83	3,580
TOTAL.......		32	99.9	109,471		

Equation (38) would merely predict the total number of visits to the site, which is the information from which the equation was derived. However, in this study the main interest lies in predicting the results of a change in the existing situation resulting from a change in water quality on the number of visitor-days. Here the relationship is important because "visitor-days" is made up of two components - the number of visits, and the length of stay per visit. Without this equation, only the length of stay per visit would have been considered.

It should be noted that the population variable in the visits relationship is not a population of recreationists but, instead, the population of a county.

Many of the relationships that were hypothesized earlier are substantiated by the sample data. The positive coefficients of the site-characteristic variables indicate that the number of visits from a given county will increase as the characteristics improve. Also, the negative coefficient for travel cost indicates that the number of visits from a county decrease as the travel costs increase. These reactions were hypothesized.

However, two statistical problems were encountered in Equation (38). First, the population and travel cost variables are highly correlated. The simple correlation coefficient between the variables is .711. This relationship is easily explained. The counties near the recreation sites have a lower average travel cost than those counties farther away from the sites. Also, those counties close to the site have smaller populations than those farther away. Therefore, the population figure increases as the value of k increases. Johnston and Pankey [1968] observed the same phenomenon in their study.

Although the correlation between travel costs and population is easily explained, it creates difficulties. The interrelationship causes each of the variables to be relatively insignificant in the estimated equation. The population variable is significant only at the 10 percent level, while the k variable is not significant at the 10 percent level.

The other problem encountered in Equation (38) is a high level of correlation (.694) between the W variable and income. Once the W variable enters into the equation, the entry of the income variable fails to reduce significantly the variation in V. It is believed that the high correlation is the cause for the low significance levels of the coefficients and the negative coefficient estimated for income. The negative coefficient for income indicates that the number of visits from a county will decrease as average county income increases. This is not the type of relationship that was hypothesized.

To solve the two statistical problems, a new visits equation was estimated with the income and population variables deleted, since they did not explain much of the variation in the previous equation. The new equation is:

$$V = -71{,}166.121 + \underset{(460.199)}{7{,}141.764\,W^{\#\#\#}} + \underset{(1{,}651.425)}{19{,}825.384\,F^{\#\#\#}} \qquad (39)$$

$$+ \underset{(.059)}{.641\,Si^{\#\#\#}} - \underset{(115.473)}{379.786\,k^{\#\#\#}} \qquad R^2 = .868^{\#\#\#}$$

Degrees of freedom = 72.

All variables in Equation (39), including the travel cost variable, are significant at the 1 percent level. The R^2 of the new equation is only slightly lower than the R^2 of Equation (38).

In order to test its ability to predict accurately, Equation (39) was used to estimate the original visits data received from the U.S. Forest Service. This is done in the following manner. Substituting the values of W, F, and Si variables for Klamath Lake into Equation (39) gives:

$$V = 26{,}119.751 - 379.786\,k \qquad (40)$$

where W, which is the sum of the swimming, boating, and water skiing use-intensities listed in Table 1, is equal to 2; the fishing use-intensity (F) is 1; and the lake size, in acres, is 98,560.

Substitution of the recreationists' average travel costs from each county, which are listed in Table 3, gives an estimate of the number of visits to Klamath Lake from each county. For example, using Klamath Lake and Deschutes County, Equation (40) yields the following estimate:

$$V = 26{,}119.751 - 379.786\ (\$4.67)$$

$$V = 26{,}119.751 - 1773.601$$

$$V = 24{,}346.$$

Determination of the number of visits from each of the other counties in the same manner, and summing over all of the counties, gives an estimate of 243,211 visits to Klamath Lake. The same method is used to obtain the estimates of total visits to the three other lakes in the study. The number of visits estimated by Equation (39) for each lake are listed in Table 4.

The total number of visits to the study area, that is, the sum of the number of visits to each lake, is accurately explained by the equation (702,593 vs. 703,871). However, the distribution of the total visits among the four lakes is not accurately predicted. The number of visits to Klamath Lake and Lake of the Woods are over-estimated, while the number of visits to Odell Lake are under-estimated. The estimate for Willow Lake is quite accurate.

The particular manner in which the site characteristics are represented in Equation (39) is believed to be responsible for the lack of predictive accuracy among individual lakes. Large variations exist in the values assigned to the site characteristics in the equation. For example, lake size varied

Table 4. A Comparison of the Forest Service Estimates of Visits to Each Lake in 1968, and the Estimates Derived from the Visits Equation

Lake	U.S. Forest Service estimates of number of visits	Number of visits estimated by $V = f(W,F,Si,k)$
Klamath................	146,491	243,211
Lake of the Woods......	266,327	335,331
Odell..................	180,304	14,968
Willow.................	109,471	110,361
TOTAL........	702,593	703,871

from 320 acres to 98,560 acres; swimming, water skiing, and boating intensity ranged from 1 to 9, and so forth. Since a direct and constant relationship between visits and characteristics is implied in Equation (39), one would expect the magnitude of the site characteristics variables to influence the estimated number of visits proportionately. As very high values of the characteristics are observed, a very large estimated number of visits will be obtained. If the values of the characteristics are generally low, a very low estimate of the number of visits will be forthcoming. This phenomenon can be seen to exist in this study. To avoid this problem, the original U.S. Forest Service estimates are used to obtain the aggregate demand functions and net economic value of each site. That is, when q_1 is multiplied by V to obtain the aggregate demand model, Vq_1, the Forest Service's estimates of V for 1969 are used.

However, the estimated equation is used in another context. It is employed to predict the number of visits subsequent to a change in water quality at Klamath Lake by assigning new values to the site characteristics in the equation. Since the new values of the characteristics are larger than the original values, and since the coefficients of these variables are positive in the visits relationship, an increase in the number of visits is forthcoming. However, the increase in the estimated visits should be expressed as a percent change in total visits. Since Equation (39) predicts the total number of visits to all four lakes quite accurately, it is assumed that it can adequately predict a percentage change in the total number of visits. This allows us to estimate the number of visits to Klamath Lake after the water quality has been improved.

Estimation of Recreational Value

The equations estimated in the previous section are used to estimate the demand for recreation at each of the four lakes in the study area. The recreationist's demand model for a lake consists of the k^*, p_1^*, and q_1 equations and the values of the site characteristic variables of that lake.

An average individual's demand curve is illustrated in Figure 10. In the figure, $\bar{p}_1^*$ is the critical daily on-site costs for the average person; $\bar{p}_1$ represents the average on-site costs per person per day; q_1^* is the length of stay per visit when daily on-site costs are at the critical level, and $\bar{q}_1$ is the number of days the recreationist will stay, per visit, if on-site costs were $\bar{p}_1$. It is here that the concept of consumer's surplus is used. It is recalled that consumer's surplus is the difference between the amount a consumer is willing to pay for a commodity and the amount he actually has to pay for it. That is, consumer's surplus can be measured as that portion of the area under the demand curve which lies above the price of the commodity. This technique is straightforward when the demand curve is shaped as the one illustrated in Figure 8. However, the demand curve in Figure 10 has a unique property in that it does not exist for quantities of recreation less than q_1^*. That is, the average recreationist will either stay at the site a minimum of q_1^* days per visit or he will not recreate at all. Therefore, it becomes a question of whether the area $\bar{p}_1^*$ AB $\bar{p}_1$ or the area ABC is the appropriate measure of consumer's surplus for a demand curve of this type. For the purpose of this study, the area of the triangle, ABC, will be used to measure the net economic value per visit. Work is continuing on the interpretation of the consumer's surplus for the case of a truncated demand curve. This solution should be viewed as one to facilitate the derivation of the remaining empirical estimates. The area ABC can be determined mathematically:

$$\int_{\bar{p}_1}^{\bar{p}^*} [f(p_1)\ dp_1] - [(\bar{p}_1^* - \bar{p}_1)(q_1^*)] = \text{value per visit.} \qquad (40)$$

The total value of the site is determined by multiplying the value per visit by the estimated number of visits to the site during the season.

The procedure described above is used to estimate the value of each of the four lakes considered in this study.

Lake of the Woods

The use-intensities of the activities and the size of Lake of the Woods were substituted into the k^*, p_1^*, and q_1 equations. The demand model for Lake of the Woods is represented by the following equations:

$$k^* = 23.617 + .0020\ y + 10.435\ p_1 \qquad (41)$$

$$p_1^* = 2.458 + .269\ k - .004\ k^2 + .000000017\ y^2 \qquad (42)$$

$$q_1 = e^{.759} - .0064\ k^* + .0064\ k + .0637\ p_1^* - .0637\ p_1 \qquad (43)$$

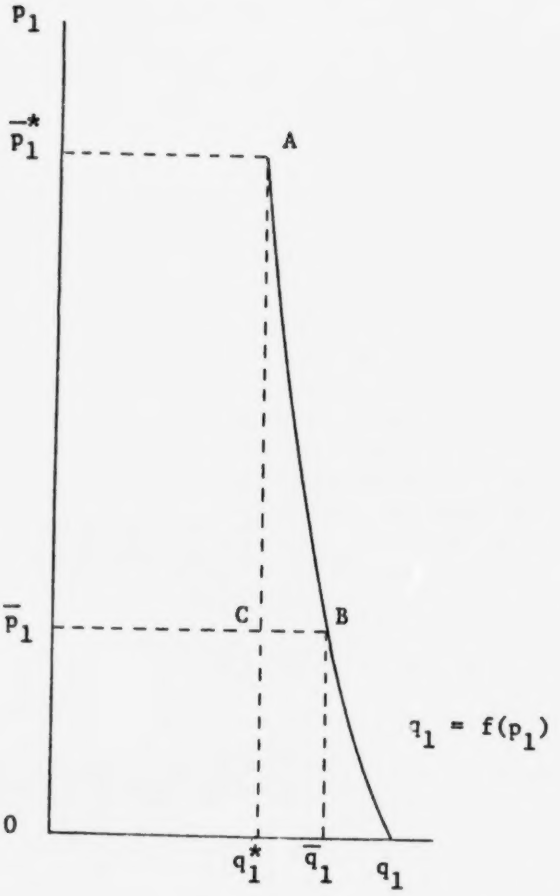
p_1
$\bar{p}_1^*$
A
C
B
$\bar{p}_1$
$q_1 = f(p_1)$
0
q_1^*
$\bar{q}_1$
q_1

Figure 10. The Average Individual's Demand Curve, Per Visit, for a Lake.

Recreationists stayed at Lake of the Woods an average of 2 days, and spent an average of \$2.01 per day. Travel costs to Lake of the Woods averaged about \$15, while the average income of recreationists was just over \$10,500. Critical on-site cost was estimated to be \$6.10, and critical travel cost was about \$66. The demand function estimated by incorporating the above data into the demand model is:

$$q_1 = e^{.821 - .0637\ p_1} \qquad (44)$$

This function is illustrated graphically in Figure 11. The value per visit is:

$$\int_{2.01}^{6.10} (e^{.821 - .0637\ p_1})\ dp_1 - [(4.09)(1.54)] \qquad (45)$$

Value per visit = \$7.17 - \$6.30 = \$0.87.

The 1968 seasonal value of Lake of the Woods is obtained by multiplying the per-visit value by the estimated number of visits in 1968:

(\$0.87)(266,327) = \$231,704.

The derived value of Lake of the Woods refers to the 1968 season. Any inferences concerning estimated value for subsequent years requires additional assumptions. It must be assumed that the reactions of recreationists remain constant, and the measured variables are not altered, or the exact change can not be specified. Use of the lake in seasons other than the summer season was not considered in this value estimate. For example, ice fishing and duck hunting performed at Lake of the Woods during the fall or winter are excluded. The above limitations also apply to the value estimates of the remaining lakes.

Odell Lake

The following equations were estimated for Odell Lake:

$$k^* = -18.076 + .0020\ y + 10.435\ p_1 \qquad (46)$$

$$p_1^* = 1.641 + .269\ k - .004\ k^2 + .000000017\ y^2 \qquad (47)$$

$$q_1 = e^{.759 - .0064\ k^* + .0064\ k + .0637\ p_1^* - .0637\ p_1} \qquad (48)$$

Recreationists stayed at Odell Lake an average of 2.4 days, spent \$2.34 daily for on-site costs, and about \$11 in travel costs. They had an average income of \$9,063, and were estimated to have critical on-site costs, p_1^*, and critical travel costs, k^*, of \$5.57 and \$24.71 respectively. The incorporation of the above information into the demand model yields the following demand function:

$$q_1 = e^{1.025 - .0637\ p_1} \qquad (49)$$

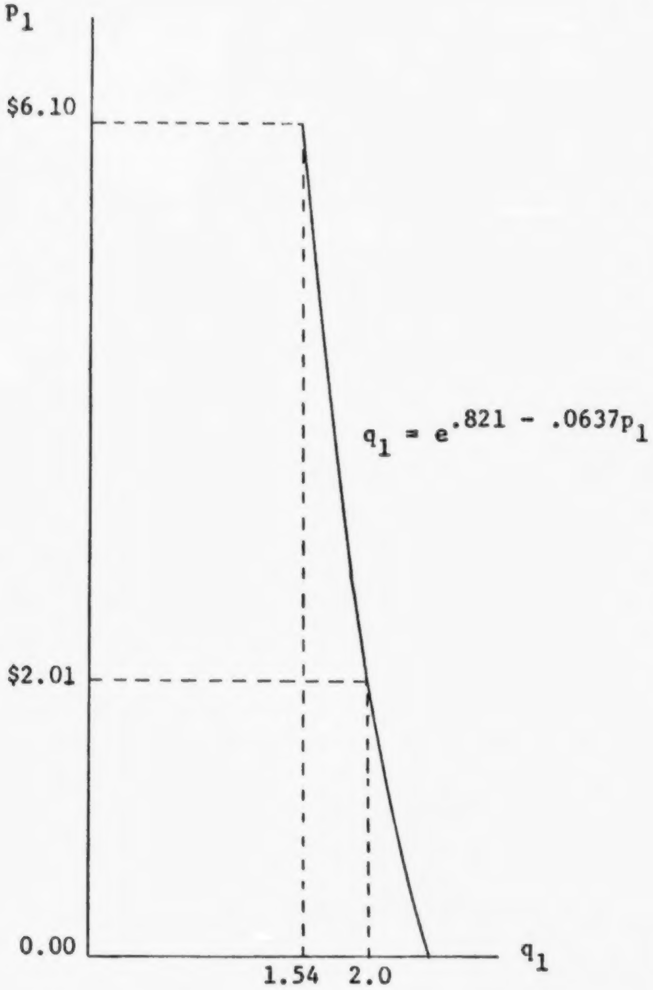

Figure 11. The Average Recreationist's Demand Curve, Per Visit, for Lake of the Woods.

The value per visit for 1968 is estimated as:

$$\int_{2.34}^{5.57} (e^{1.025 - .0637\ p_1})\ dp_1 - [(1.96)(3.23)] \qquad (50)$$

Value per visit = \$7.17 - \$6.33 = \$0.84.

When this figure is multiplied by the number of visits for the 1968 season, a total seasonal value of Odell Lake in 1968 is obtained:

(\$0.84)(180,304) = \$151,455.

Willow Lake

Willow Lake is the smallest of the four lakes in this study. However, the lake has approximately average value of the use-intensities for the various activities. When these characteristics are substituted into the k^*, p_1^*, and q_1 equations, the demand model applicable to Willow Lake becomes:

$$k^* = -6.534 + .002\ y + 10.435\ p_1 \qquad (51)$$

$$p_1^* = 2.988 + .269\ k - .004\ k^2 + .000000017\ y^2 \qquad (52)$$

$$q_1 = e^{.759 - .0064\ k^* + .0064\ k + .0637\ p_1^* - .0637\ p_1} \qquad (53)$$

The recreationists at Willow Lake recreated an average of 2.18 days per visit, and spent \$1.72 per day. They had an average income of \$7,790, and incurred approximately \$6 in travel cost per visit. The estimated critical travel cost averaged nearly \$31, while the estimated critical daily cost averaged \$4.55. When p_1^*, k^*, and k are assigned average values applicable to Willow Lake, the demand function for an individual visit is:

$$q_1 = e^{.888 - .0637\ p_1} \qquad (54)$$

The average value per visit is:

$$\int_{1.72}^{4.55} (e^{.888 - .0637\ p_1})\ dp_1 - [(2.83)(1.82)] \qquad (55)$$

Value per visit = \$5.64 - \$5.15 = \$0.49.

The seasonal economic value for Willow Lake in 1968 is:

(\$0.49)(109,471) = \$53,641.

Klamath Lake

The demand model for Klamath Lake, given its present characteristics and use-intensity values, is:

$$k^* = 9.132 + .002\ y + 10.435\ p_1 \tag{56}$$

$$p_1^* = 3.531 + .269\ k - .004\ k^2 + .000000017\ y^2 \tag{57}$$

$$q_1 = e^{.759\ -\ .0064\ k^*\ +\ .0064\ k\ +\ .0637\ p_1^*\ -\ .0637\ p_1} \tag{58}$$

The average stay per visit was 1.97 days, while average daily expenses at the site were $1.84 per person. The average recreationist had an annual income of $8,900, and allocated about $6.80 to travel costs per visit. Average critical values of travel cost and on-site costs were estimated at approximately $55 and $5.54 respectively. Using these values, the demand function for Klamath Lake, as it now exists, is:

$$q_1 = e^{.801\ -\ .0637\ p_1} \tag{59}$$

The economic value of Klamath Lake for the summer of 1968 is computed in the same manner as for the other lakes:

$$\int_{1.84}^{5.54} (e^{.801\ -\ .0637\ p_1})\ dp_1 - [(3.70)(1.57)] \tag{60}$$

Value per visit = $6.37 - $5.81 = $0.56.

The economic value of Klamath Lake, given its present characteristics, is obtained by multiplying the value per visit by the number of visits to the lake in 1968:

($0.56)(146,491) = $82,035.

SECTION VII

THE THEORETICAL MODEL FOR ESTIMATING REGIONAL BENEFITS

The three preceding sections present methods for estimating the demand for recreation and the economic value of four recreational sites. Before the model is used to estimate the benefits resulting from water quality improvements at Klamath Lake, let us look at the procedures used to estimate the local economic impact resulting from water quality improvements at the lake.

As pointed out, the local community is often the recipient of indirect benefits as the result of a project which increases the economic activity of the region. To measure the magnitude of these benefits, it is necessary to determine the economic structure of the region. Because of its unique ability to portray the structure of an economy, a regional input-output model was selected for use in this study.

An input-output model portrays the flow of goods and services throughout the economy. It provides a means to measure the impact of changes in the overall economic activity of the economy, resulting from a change in the activity of any one segment of the economy. Two reasons have been cited [Stoevener and Castle, 1965] why the interdependencies portrayed by an input-output model are important. They are: (1) the determination of the aggregate level of regional secondary benefits, and (2) the distribution of these benefits. Knowledge of the distribution of the regional benefits among the various sectors of the economy may be especially important if institutional arrangements for cost-sharing are to be made among the various beneficiaries.

Input-Output Theory

Although some of the basic concepts had been developed earlier, Wassily Leontief is usually credited with the introduction of input-output analysis. In his first publication on the subject in 1936, Leontief introduced input-output analysis as an empirical tool. Since Leontief's first publication, several extensions and alternative uses of the model have been developed. The input-output method has spread rapidly, and is a widely used economic tool in the world today. The volume of literature relating to input-output analyses is so large that several bibliographies have been compiled (Riley and Allen [1955], Taskier [1961], and Input-Output Bibliography 1960-63 [1964]), and international conferences relating to input-output analysis have been held.

An input-output model is illustrated by a "transaction matrix". It describes the flow of goods and services between the sectors of the economy in a given time period. A sector is made up of a group of firms that carry on similar types of business. The criteria used to define a sector will be discussed later in this section. A simplified transactions matrix is presented in Table 5. The hypothetical economy is divided into three sectors. Each of the sectors is listed twice in the matrix - once as a "producing sector", indicated by the row heading, and again as a "purchasing sector", shown by the column heading. The first three rows of the matrix describe how the total output of Sector i (i = 1, 2, or 3) is distributed among the various sectors of the economy. The first three columns describe Sector j's (j = 1, 2, or 3) purchases of inputs from the various sectors of the economy. Therefore, the x_{ij}'s, which represent the intersectoral flows, represent the dollar value of goods and services sold by Sector i to Sector j.

Table 5. A Hypothetical Transactions Matrix

		Purchasing Sectors				
		1	2	3	Final demand	Total output
Producing Sectors	1	x_{11}	x_{12}	x_{13}	Y_1	X_1
	2	x_{21}	x_{22}	x_{23}	Y_2	X_2
	3	x_{31}	x_{32}	x_{33}	Y_3	X_3
	Value added	V_1	V_2	V_3	V_f	
	Total purchases	X_1	X_2	X_3		

The Final Demand column of the transactions matrix, represented by the Y_i's (i = 1, 2, 3) shows how much of the producing sector's output is consumed as a "final good". Outputs allocated to final demand are not re-used as intermediate inputs in producing other goods and services within the economy under study. Final demand is referred to as the exogenous or autonomous portion of the input-output system, because the level of demand is not dependent upon the level of economic activity within the economy being studied. The components usually assigned to final demand in an open input-output model are consumption, investment and inventory accumulation, purchases of the various levels of government, and exports.

The last column of the transaction matrix represents Total Output. Total output of Sector i (X_i) is the sum of its sales to other sectors and to final demand:

$$X_i = \sum_{j=1}^{3} x_{ij} + Y_i \qquad (i = 1, 2, \text{ or } 3) \qquad (61)$$

The Value-Added row of the transactions matrix is composed of the payments made by the various sectors for "primary inputs" used in their production processes. The components of the Value-Added row are payments to all levels of government for services rendered, payments to households for labor and entrepreneurial services, imports, depreciation of capital equipment used in the production process, and depletion of inventories. A sector purchases produced inputs from the other sectors and produces a new product of greater value. The increase in value is reflected in the payments made for the primary factors of production, which are recorded in the Value-Added row.

At first it may appear that imports should not be included in the Value-Added row, since they may consist of intermediate goods produced by other economies. However, imports represent primary inputs into the economy being studied, and they are being used in a production process within that economy. Therefore, their value is reflected in the producing sector's product, and must be included in the Value-Added row.

It should be noted that some of the components of final demand may also purchase primary inputs. For example, wages paid to government employees represent purchases of primary inputs. The symbol V_f in the transactions matrix represents the value of all purchases of primary inputs made by the components of the final demand sector. Although the V_f portion of the matrix adds additional information, it is not necessary to know these values to solve the model.

The final row of the transactions matrix represents Total Purchases. Total purchases of Sector j (X_j) are the sum of all inputs used in the production process of that sector:

$$X_j = \sum_{i=1}^{3} x_{ij} + V_j \qquad (j = 1, 2, \text{ or } 3) \qquad (62)$$

The model used in this study is referred to as an "open" model. However, the model may be "closed" with respect to the household or government component of final demand by including either or both as an additional sector in the processing portion of the economy. For example, the model can be "closed" with respect to households by removing consumption from final demand, and payments to households from value added, and forming a "Households" sector in the endogenous portion of the model. Formation of a households sector gives a more complete picture of the economy, because it shows the relationship that exists between household income and expenditures. However, the cost of obtaining the additional necessary information prevented the construction of a household sector in this study. The model constructed in this study is, however, closed with respect to the local governments in the region.

A final characteristic of the transaction matrix should be noted. The total output of each sector is equal to its total purchases:

$$X_i = X_j \qquad \text{where } (i = j)$$

This characteristic is a manifestation of Euler's Theorem, which states that, under conditions of constant returns to scale (linear, homogenous production functions), "total product is equal to the sum of the marginal products of the various inputs, each multiplied by the quantity of its input" [Stigler, 1966, p. 152].

Direct Coefficients Matrix

The transactions matrix is used to derive the direct coefficients matrix. This step relies upon one of the basic assumptions of input-output analysis. It is assumed that the level of inputs purchased by a sector is dependent upon the level of total output of the purchasing sector. Moreover, inputs are purchased in a direct and constant relationship to the output of the sector. From this assumption we can derive the direct coefficient, a_{ij}. We recall from the transactions matrix that the x_{ij} represents Sector j's purchases from Sector i, and that the total output of Sector j was recorded in the Total Output column. It follows directly from the assumption that:

$$a_{ij} = \frac{x_{ij}}{X_j} \qquad (63)$$

where a_{ij} = the direct coefficient, and

X_j = total output of Sector j.

By solving Equation (63) for x_{ij}, and substituting it into Equation (61), a new equation for total output is obtained:

$$X_i = \sum_{j=1}^{3} a_{ij} X_j + Y_i \qquad (i = 1, 2, \text{ or } 3) \qquad (64)$$

Direct coefficients indicate the value of inputs Sector j must purchase from Sector i to produce one dollar of output. They illustrate the direct interdependencies that exist between the sectors of the economy. For example, an increase in the output of Sector 1 will lead to increased output in Sectors 2 and 3 (providing $a_{ij} > 0$), because Sector 1 will require additional inputs from Sectors 2 and 3 to produce its increased output.

The Direct and Indirect Coefficients Matrix

The direct coefficients do not, however, explain the full addition to total output caused by an increase in demand of the Sector 1 product. As Sectors 2 and 3 increase output to satisfy the additional requirements of Sector 1, they must also purchase more inputs from the various other sectors to produce their increased output. This causes another increase in the level of demand within the economy. Therefore, a change in the output of one sector will cause direct and indirect increases in the output of other sectors. The matrix of direct and indirect coefficients is used to describe the total effect an exogenous change in the demand of one sector will have upon the output of the entire economy.

The matrix of direct and indirect coefficients, or the "R" matrix, is derived from Equation (64). Rearranging Equation (64) gives:

$$X_i - \sum_{j=1}^{3} a_{ij} X_j = Y_i. \qquad (65)$$

Rewriting Equation (65) in matrix notation yields:

$$X - AX = Y, \qquad (66)$$

where X is the column vector of total output,

A is an nxn (where n = 3 in our example) direct coefficients matrix, and

Y is the final demand column vector.

Factoring X out of the left side of the equation yields:

$$X(I - A) = Y \qquad (67)$$

where I is an identity matrix of the same dimensions as the A matrix.

The identity matrix has the characteristic that, when multiplied by another matrix of the same dimensions, it does not change the original matrix. It serves the same purpose in matrix algebra that multiplying by unity serves in arithmetic algebra. The main-diagonal cells of the identity matrix contain unity, while all other cells in the matrix are zero.

Solving Equation (67) for X yields:

$$X = (I - A)^{-1} Y. \qquad (68)$$

The $(I - A)^{-1}$ or "R" matrix is also called the matrix of direct and indirect coefficients. Each coefficient shows the output of Sector i needed by Sector j to deliver one dollar of its output to final demand. It takes into account the direct and indirect effects caused by a change in final demand of one of the processing sectors. The availability of digital computers has made the method of matrix inversion the most popular means of obtaining the interdependence coefficients, since other methods using simultaneous equations are more cumbersome.

Input-Output Assumptions

Three general assumptions are used in input-output analysis:

(1) Each commodity is supplied by a single sector.

(2) The inputs purchased by each sector are dependent upon the level of output of that sector.

(3) The total effect of carrying on several types of production is equal to the sum of the separate effects.

The first assumption implies that each sector uses only one method of production, and that only one primary output is produced by each sector. This assumption requires satisfactory criteria by which to aggregate the numerous economic activities in the economy into sectors. Ideally, two criteria should be used in defining sectors. They are to aggregate industries with similar input structures, and/or industries that produce strictly complementary outputs [Chenery and Clark, 1959]. It is seldom possible to strictly follow these criteria when constructing a model, but they should be adhered to as closely as possible, to insure more stable input coefficients.

Another point should be considered in the aggregation process. It should be clear to the researcher how the model is to be used after its completion. More aggregation in some industries may be possible if they are not expected to be important in the model's final use. Likewise, increased specialization may be beneficial in the industries that are of major interest in the analysis. For example, in this study it was felt that the major portion of recreational spending would be spent on gasoline, groceries, prepared food, and lodging. Therefore, a sector was designed for each of these categories, to obtain a more detailed analysis.

The second assumption, that the amount of inputs purchased by a sector is a function of the level of the output of that sector, was mentioned earlier. This is the most important assumption of input-output analysis. However, it has drawn criticism from sources who feel it does not apply in the real world. These criticisms will be mentioned in the next subsection.

The third assumption of additivity disallows external economies and diseconomies. It states that all the production processes carried on within the economy are independent of each other. One production process has no effect - either beneficial or detrimental - upon any other production process.

Limitations of the Model

Some doubt has been expressed concerning the ability of input-output models to predict accurately. Many feel that the assumptions upon which the model are based are too restrictive and unrealistic to give meaningful predictions. Most of the criticisms have centered around the assumed fixed direct coefficient because it ignores three changes that can occur in an economy [Chenery and Clark, 1959]. They are: (1) changes in the composition of demand, (2) changes in the relative prices of inputs, and (3) changes in production technology. Of the three, a change in technology is usually considered to have the greatest effect upon the direct coefficients.

Although the changes listed above will certainly affect the input coefficients in the long run, their effects may be minimal over shorter periods of time. Even though new production processes become available, existing techniques are often used until capital items have depreciated and new plants are built. In the same vein, changes in the composition of demand and input substitutions usually occur gradually. Therefore, it would seem that the assumption of fixed input coefficients would be justifiable in the short run.

Cameron [1953], in a time series analysis of selected input coefficients from the Australian model, concluded that his results generally supported the assumption of fixed input coefficients in the short run. The most important input coefficients appeared to remain relatively constant for a period as long as a decade. The substitution that did occur between inputs appeared to be caused by a change in the product-mix of the industry, and not changing technology or price ratios. However, caution should be exercised. One must be aware of the limitations of the model and restrictions of the assumptions, to prevent misusing the model.

Regional Input-Output Models

Regional input-output models, such as the one constructed in this study, have become a popular analytical tool. A wide variety of types of regions have been analyzed. In most cases regions have been defined by using political boundaries - that is, counties, states, or multi-state regions. However, geographic characteristics, such as river basins, have also been used to define the boundaries of study areas.

A regional model is constructed in the same manner as a national model. Thus, the regional model is open to the same criticisms discussed earlier. However, obtaining the data necessary to construct a regional transactions matrix has been the dominant problem faced by the regional researcher. Although it is expensive, extensive interviewing is often the only available means to obtain the data required to construct a model.

Modifications of the Basic Model

The model constructed for this study is a regional input-output model, but it differs slightly from the basic input-output model that was just presented. The previous model was concerned with the technical input structure of the various sectors. This gives the model a technical orientation in that the input structure of each sector is determined by the state of technology used by the sector. In the Klamath County model the trade flows of the sectors of the economy are studied, instead of the more technical input-output relationships. Therefore, the a_{ij}'s may more accurately be termed "trade" coefficients rather than technical coefficients. A model of this type has been called a "from-to" model [Leven, 1961].

There is one other conceptual difference between the Klamath County model and the basic input-output model. In the latter model, all transactions involving capital items are removed from the endogenous flows. They are then included in the investment component of final demand. This is necessary, since investment purchases usually are not a function of the current level of output.

However, in a from-to model, where the a_{ij}'s are interpreted as trade coefficients rather than input coefficients, it is not necessary to remove capital item purchases from the interindustry flows. Only the gross flow of goods and services between the various sectors is relevant in the from-to model.

The inclusion of investment purchases in the endogenous flows of the model does, however, raise an important question: What effect does their inclusion have upon the stability of the trade coefficients? At first it may appear that including investment purchases in the interindustry flows would decrease the stability of the coefficients, since investment decisions are not determined entirely by current output trends. That is, investment purchases are cyclical, and reflect conditions other than those portrayed in the model. Therefore, the interindustry flows would vary as investment purchases varied.

To determine if the inclusion of investment purchases reduces the stability of the coefficients, two types of investment cycles must be considered. The first is the cyclical investment decisions of the individual firm. A firm usually does not have a constant rate of investment over a given period of time. Instead, a large investment is usually made during some year, while smaller investments are made during other years. This type of investment cycle may not significantly affect the stability of the trade coefficients. One firm may purchase capital items during one year, and another firm may invest the following year. Therefore, if the firms are sampled in a random fashion, the observed level of investment may reflect a relatively stable yearly estimate for all of the firms in a sector.

The other investment cycle of importance is that observed for the entire economy. Aggregate investment varies from year to year. This variation is due to several factors, including the expectations of businessmen and the availability of investment funds which may be subject to changes in national fiscal and monetary policies. If data were gathered during a year when investment spending was significantly above or below its usual level, inclusion of investment purchases in the interindustry flows would distort the coefficients. To determine if this had occurred in this study, national aggregate investment figures were studied [Board of Governors of the Federal Reserve System, 1968]. The data indicated that investment spending at the national level increased sharply in the second half of 1968. However, whether the Klamath County economy experienced the same general increase in investment at that time cannot be determined. Therefore, one can only conclude that the trade coefficients estimated for the Klamath County model may have been subject to cyclical investment fluctuations, but the extent of that effect, if any, could not be determined.

SECTION VIII

CONSTRUCTION OF THE FROM-TO MODEL AND AN ANALYSIS OF THE LOCAL ECONOMY

The first step in the construction of the from-to model is to define the study area. Klamath County was selected as the study area, primarily because it includes the communities that would benefit from expanded use of Klamath Lake. Defining the county as the study area also offers additional benefits. Secondary data that would aid in the study are available on a county basis. Also, defining the study area to coincide with political boundaries is advantageous, since the model may provide useful information to county planning and development groups. A map of Klamath County is provided in Figure 12.

Sampling Procedures

Since sampling techniques were to be used to obtain the data required to construct the model, a listing of all the business firms in Klamath County was obtained. Three secondary sources were relied upon to compile the population. They are: (1) the 1968 telephone directory of Klamath Falls and surrounding communities, (2) a listing of business firms in Klamath County, received from the Klamath County United Good Neighbors, and (3) the 1967 Klamath Falls City Directory. A final population included 1,840 business firms.

Each firm in the population was then placed in the appropriate sector of the model. Table 6 contains the sectors of the model and examples of the types of firms in each sector. The Household sector is also defined in the table, although it is not included as a sector in the processing portion of the matrix. A firm with multiple economic activities, such as selling and servicing, was placed in the sector that described its largest income-producing activity.

After each firm had been assigned to the appropriate sector of the model, most of the sectors in the model were stratified so that the firms in each sector could be grouped into more homogenous categories than a sectoral grouping alone could provide. By increasing the homogeneity of a group of businesses, a smaller sample could be used to obtain information about the businesses in each stratum.

Two types of stratification were used. All sectors except Agriculture, Professional Services, Service-Oriented, Resorts and Marinas, and Local Government were stratified according to size. That is, each firm in the sector was placed into a size group, usually large, medium, or small, within the sector. For example, if the gross sales of a firm were thought to be large, relative to the other firms in the sector, the firm was placed in the large-firm stratum.

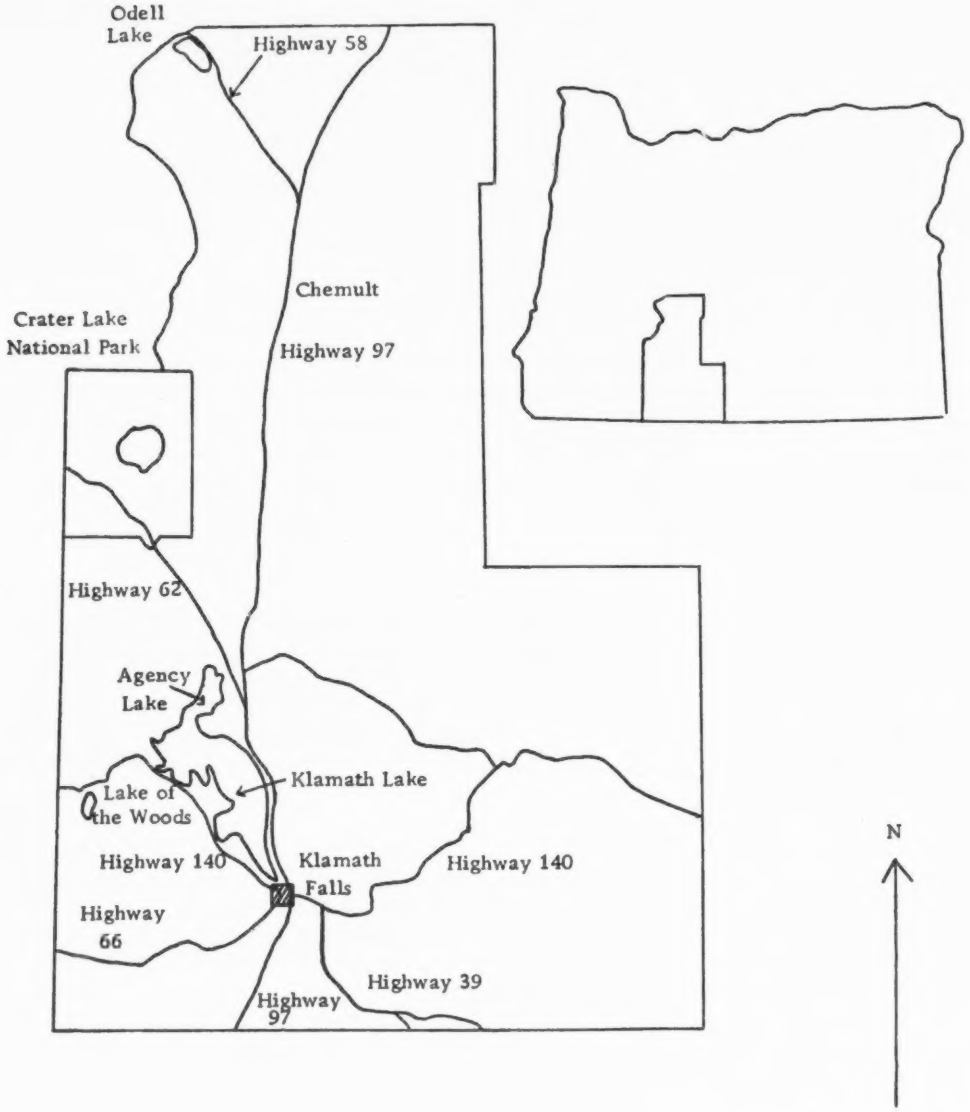
Odell Lake
Highway 58
Chemult
Crater Lake National Park
Highway 97
Highway 62
Agency Lake
Klamath Lake
Lake of the Woods
Highway 140
Klamath Falls
Highway 140
Highway 66
Highway 39
Highway 97
N

Figure 12. Klamath County, Oregon.

Table 6. Description of the Sectors in the Klamath County Model

Sector number	Sector title	Sector description
1.	Agriculture	Farms, ranches, and feedlots.
2.	Agricultural Services	Farm implement dealers, farm cooperatives, feed, seed, and fertilizer stores, livestock auction yards, and irrigation pump dealers.
3.	Lumber	Logging, log hauling, lumber and plywood mills.
4.	Manufacturing and Processing	Potato processors, creameries, bottling companies, meat and poultry processors, machine manufacturing, trailer manufacturers, and stone, clay, and glass manufacturers.
5.	Lodging	Hotels, motels, trailer parks, and apartments.
6.	Cafes and Taverns	Businesses that sell beverages and prepared food that may be consumed on the premises.
7.	Service Stations	Gasoline bulk plant distributors, service stations, and heating fuel distributors.
8.	Construction	General building contractors, electrical and plumbing contractors, sand and gravel operations, asphalt paving contractors, carpenters, concrete manufacturers, excavators, land levelers, road and highway contractors, roofing and painting contractors, masonries, and well-drillers.
9.	Professional Services	Doctors, dentists, lawyers, accountants, architects, surveyors, engineers, hospitals, veterinarians, ambulance services, and nursing homes.
10.	Product-Oriented (wholesale and retail)	All firms that receive the largest part of their income from the sale of products at the wholesale or retail level that are not included in other sectors. Examples: utility companies, department stores, specialty stores, drug stores, and bottled beverage distributors.
11.	Service-Oriented	Firms that receive the largest part of their income from the sale of services.

(Continued on following page)

Table 6. (Continued)

Sector number	Sector title	Sector description
		Examples: beauty and barber shops, insurance and real estate agencies, repair stores, laundries, churches, social organizations, and labor unions.
12.	Communications and Transportation	Trucking firms, railroads, airlines, buses, radio, television, telephone, telegraph, newspapers, and television cable.
13.	Financial	Banks, savings and loan associations, loan companies, and securities investment businesses.
14.	Grocery	Firms which sell food for off-premise consumption. Examples: grocery stores, seafood stands, meat stores, and fruit stands.
15.	Resorts and Marinas	Stores at recreational sites, marinas, and boat dealers.
16.	Automotive	Auto and trailer sales, tires, parts and accessory stores, and auto repair shops.
17.	Local Governments	County and city governments, school districts, and special taxing districts.
	Households	All private individuals.

The Professional Services, Service-Oriented, and Resorts and Marinas sectors were stratified on the basis of the economic activities within the sector. For example, in the Professional Services sector, physicians were put in one stratum, dentists in another stratum, accountants in a third, and so forth. Alternatively, each of these strata could have been considered as an additional sector. This would have led to a much larger number of sectors than were used in the study. However, it was felt that the benefits from increased homogeneity in the smaller sectors were not sufficient to compensate for the increased difficulty of collecting data for a more highly disaggregated model.

Data for the Agriculture and Local Government sectors were not collected by the same procedure. They will be discussed later in this section.

Determination of the Sample Size

To estimate the sample size, the variances of the variables to be estimated must be known. Since estimates of the variances were not available, other techniques had to be used to determine the sample size. Two factors were considered. The first was the amount of funds available for collecting the data; the other was the sampling rate used in previous input-output studies in Oregon. In previous studies by Bromley [1967] and Stoevener [1964], the sampling rates were between 25 and 30 percent of the total population.

After considering these factors, a sample size of 500 was selected. This is equal to about 27 percent of the population. A 10 percent oversample was drawn, to allow for incomplete questionnaires and refusals. Therefore, the total sample consisted of 550 firms.

Allocation of the Sample

Three criteria were considered to allocate the total sample among the various sectors. They are: (1) the number of firms in each sector, (2) an estimate of the gross sales of each sector, and (3) the amount of variability in size and types of economic activity in each sector. In the case of the first criterion, an allocation of the sample was made, based entirely upon the number of firms in each sector. If a sector contained 10 percent of the businesses in the county, 10 percent of the sample was allocated to that sector.

The second criterion was used to give a weighting factor to each sector, based upon its total output relative to the total output of the entire economy. In order to do this, it was necessary to obtain an estimate of the total output of each sector. Secondary sources were used to obtain these estimates. Even though complete sales data were not available for all the sectors, it was possible to get a general indication of the volume of sales. These estimates were then used to allocate the sample on the basis of the total output of each sector.

As mentioned previously, data were not available to estimate the variances of the parameters to be estimated. However, a subjective measure of variability was considered in the allocation of the sample. Two types of variability were studied. The first was the variation in the size of firms in each sector. The other dealt with the amount of diversification as to the types of economic activity in the sector.

The two sample allocations, based on the number of firms in the sector and the total sales of the sector, provided a range for the sample size for each sector. The variability within each sector was then considered. If the variability was considered to be large, the actual sample size allocated to the sector was taken from the upper portion of the range that had been determined. Table 7 lists the sectors and the allocation of the sample.

Table 7. Distribution of the Sample Among the Sectors of the Model

Sector	Number of Firms	
	Population	Sample
1. Agriculture	*	*
2. Agric. Services	25	17
3. Lumber	39	17
4. Manufacturing & Processing	36	20
5. Lodging	165	36
6. Cafes & Taverns	119	26
7. Service Stations	135	34
8. Construction	156	40
9. Professional Services	160	33
10. Product-Oriented	259	100
11. Service-Oriented	442	123
12. Communications & Transportation	60	23
13. Financial	30	15
14. Grocery	95	29
15. Resorts & Marinas	15	4
16. Automotive	104	34
17. Local Governments	*	*
TOTAL ECONOMY	1,840	551

* Secondary data was utilized in these sectors.

Once the sample size had been determined for each sector, it was necessary to allocate the sector sample size among the various strata in each sector. All of the firms classified as "large" were included in the sample. A random sample was then drawn from each remaining strata of each of the 15 sectors that were sampled. The sample drawn included 551 firms.

Local Governments

Since data concerning local governments were readily available, it was not necessary to include the various units of government in the county in the interviewing process. The expenditures of all governmental units were obtained for the 1967-68 fiscal year. These expenditures were then allocated to the various sectors in the model, with the assistance of the bookkeeper or purchasing department of each unit of government. These data were used to fill in the Local Governments column in the transactions matrix.

Agriculture

Agriculture, being the second largest industry in Klamath County, is an important sector in the model. The 1964 Census of Agriculture estimated that there were more than 1,000 farms in Klamath County. However, more secondary data were available for agriculture than for any other sector. It was felt that the necessary estimates could be determined from the available data, without the collection of primary data.

Sampling Results

Personal interviews were conducted with each firm in the sample. It became obvious in the early stages of data collection that 500 responses would not be obtained from the 551 firms in the sample. Therefore it was necessary to draw replacements for 175 non-responding firms. The allocation of the second sample was determined by the number of firms in each stratum that did not respond in the first sample. If four firms did not respond in a particular stratum, four additional firms were drawn from that stratum to replace the non-responding firms. Completed questionnaires were eventually obtained from 438 firms.

Several factors contributed to the low response rate. First, relying upon secondary sources to compile the list of businesses resulted in including firms in the sampling frame that were no longer in business. Lists of businesses become obsolete very rapidly, due to the rate of business turnovers.

A second factor contributing to the non-response rate was the type of data being collected. In order to construct the model, detailed financial data were required from each firm in the sample. Most of the refusals resulted from firms who considered the data to be confidential and, therefore, would not release it.

The type of businesses in the study area also contributed to the poor response. Many of the businesses in the county are sub-divisions of larger companies. In many cases they did not have the detailed information available at their Klamath County office. The head offices of these companies were contacted by mail and telephone. However, the interviewing procedures used in the study were not well designed for these non-personal contacts, and many firms did not reply to the requests for information. Other firms indicated they did not maintain the type of data requested for individual branch offices of the company, and therefore could not respond. Furthermore, it was not possible to determine the owners of some businesses such as self-service laundromats and car washes.

Therefore, some firms of this type could not be contacted. The 438 completed interviews represent nearly 24 percent of the firms in the county. The questionnaire used to obtain the data is included in Appendix B.

The Klamath County Economy

Transactions Matrix

The transactions matrix, presented in Table 8, was constructed from the collected data. As mentioned earlier, each sector of the economy is listed at the left, and the numbers at the top of the matrix correspond to the numbered sectors at the left. Those listed at the left represent the selling sectors, while those across the top indicate the purchasing sectors. The figures in the cells of the matrix indicate the value of goods and services sold by the sector at the left to the sector at the top. For example, reading across the Agriculture row shows that it sold $6,189,800 worth of goods and services to Agriculture (intraindustry sales), $602,220 to Agricultural Services, zero to Lumber, $9,484,110 to Manufacturing and Processing, and so on across the row. The distribution of sales of each of the other 17 sectors can be determined in the same manner.

The purchases of each sector of the economy can also be determined from the transactions matrix. This is done by reading down the column of a sector. For example, reading down the first column shows that Agriculture purchased $6,189,600 of goods and services from itself, $4,445,044 from Agricultural Services, $75,660 from Lumber, $168,712 from Manufacturing and Processing, and so on down the column.

The first 17 rows and columns comprise the endogenous portion of the transactions matrix. Row 18 is the sum of the first 17 rows in each column. The figures indicate the total value of goods and services the sector purchased within the local economy. The figures provide a general indication of how much that sector depends upon the local economy. The larger the figure, relative to the total purchases of the sector (Row 23), the greater the magnitude of dependence of that sector, in terms of its inputs, upon the other sectors of the local economy.

Rows 19-22 comprise the value-added portion of the matrix. The Household row (19) indicates the value of services purchased from private individuals. It includes such payments as wages, returns to entrepreneurial services, interest, dividends, and rent. This figure indicates another characteristic of the various sectors - the larger the payments to Households, relative to the total purchases of the sector, the more labor-intensive is the industry.

The Import row (20) depicts the purchases of goods and services from outside the Klamath County economy. This provides a measure of the degree of self-sufficiency of the economy. The large volume of imports purchased by the sectors in this model indicates that the economy of Klamath County is not nearly self-sufficient.

Table 8. Transactions Matrix Showing Interindustry Flows in Dollars, Klamath County, 1968 (Rounded to Nearest $1,000)

	PURCHASING SECTOR																					
SELLING SECTOR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	19	20	21	22	23
1. Agriculture......	6190	602	0	9484	0	35	0	0	12	0	0	0	0	160	0	0	1	88	12223	58	0	28854
2. Agric. Services..	4445	206	37	203	3	3	0	12	3	0	46	12	0	0	6	3	82	1574	4108	703	316	11129
3. Lumber...........	76	0	9079	143	0	0	3	425	0	575	3	0	0	8	0	0	0	164	66842	1589	912	79819
4. Manufacturing & Processing.....	169	*	149	*	82	720	0	294	26	375	21	1	0	3887	26	0	314	1886	11621	3363	222	23155
5. Lodging..........	0	0	*	0	0	0	0	6	*	0	*	0	7	0	0	*	*	4145	117	50	0	4326
6. Cafes & Taverns..	0	1	19	*	0	0	0	18	0	0	0	0	*	0	0	0	1	6389	7	7	21	6464
7. Service Stations.	931	83	660	149	47	561	1685	437	52	213	95	362	1	35	92	41	161	10505	644	108	37	16394
8. Construction.....	175	0	260	228	33	104	64	2214	28	927	231	7	44	22	2	23	565	6232	629	6818	28	18613
9. Professional Services.......	132	15	39	25	12	7	15	37	8	18	77	19	11	11	2	20	115	12554	411	1158	53	14740
10. Product-Oriented.	918	371	1960	626	773	1871	346	971	261	993	815	242	173	1763	64	224	782	25394	5895	2106	1037	47564
11. Service-Oriented.	430	57	169	46	162	203	100	292	134	257	849	15	305	110	23	254	314	11768	668	253	72	16480
12. Communications & Transportation.	244	760	12880	2584	331	54	146	322	230	1887	424	100	109	429	0	182	103	4833	2577	1844	13	30053
13. Financial........	665	128	620	146	96	17	49	148	59	82	48	17	65	17	17	433	0	3325	148	0	0	6079
14. Grocery..........	26	0	48	0	0	174	0	0	0	8	0	19	0	1009	0	0	43	21822	651	176	84	24060
15. Resorts & Marinas........	5	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	1	684	3	1	9	703
16. Automotive.......	218	77	1000	68	0	0	326	193	58	445	128	92	5	7	12	1084	343	14700	379	458	344	19936
17. Local Gov't......	1363	40	1204	96	96	41	51	70	79	986	297	810	42	57	29	60	75	1892	0	5942	0	13230
18. Summation[a]......	15985	2338	28122	13799	1636	3285	2765	5439	951	6765	3035	1697	762	7466	274	2324	2899	127953	106924	24002	3147	361597
19. Households.......	9629	1167	22774	3582	1590	2213	2493	4760	8147	8496	6103	8660	1526	2395	109	3338	8466					95449
20. Imports..........	61	7203	15634	4539	502	344	10283	7383	4108	27114	5937	13514	3354	13419	281	13267	907					127849
21. Government.......	573	130	8166	645	137	327	569	504	758	4325	917	3707	291	482	22	378	958					22889
22. Depreciation & Negative Inventory Changes...	2607	289	5123	591	461	294	284	527	776	863	488	2475	147	269	17	629	0					15840
23. Total Inputs[a]...	28854	11129	79819	23155	4326	6464	16394	18613	14740	47564	16480	30053	6079	24060	703	19936	13230	127953	106924	24002	3147	623623

[a] May not sum, due to rounding error.

* Number in cell rounds to zero.

Columns 19 through 22 comprise the final demand for goods and services sold by the sectors listed at the left of the matrix. The four components of final demand indicate the major uses of the goods and services sold. The Household column (19) represents the value of goods and services sold to individuals, while the Government column (21) shows the value of sales to state and federal governments. Column 20 represents exports from Klamath County by the various sectors, while Column 22 indicates positive inventory changes. Column 23 summarizes total sales by each sector. The remaining rows and columns of the transactions matrix are self-explanatory.

Direct Coefficients Matrix

The direct coefficients, or "A" matrix, is presented in Table 9. The matrix is utilized by reading down the columns in order to determine the input structure of the sectors of the economy. In most cases, the a_{ij}'s, which represent Sector j's purchases per unit of output, reveal more about the structure of a sector than the absolute magnitude of interindustry sales depicted in the transactions matrix.

The first column of the "A" matrix shows that Agriculture must purchase 21 cents worth of goods and services from itself if it is to increase its output by one dollar. Continuing down the column, Agriculture must also purchase 15 cents worth of goods and services from Agricultural Services; less than one cent from Manufacturing and Processing, and Lumber; zero from Lodging, and Cafes and Taverns; and so on down the column. The Summation row (18) shows that Agriculture purchases over 55 cents worth of goods and services from the local economy for every dollar of output. Row 19 shows that Household incomes increase 33 cents per dollar increase in sales of the Agriculture sector.

Characteristics of the Economy

Some of the characteristics of the local economy can be studied, using the numbers in the transactions and direct coefficients matrices. A breakdown of the sales of each of the 17 sectors is given in Table 10. The dollar value and percentages of sales are separated between the local economy and final demand. It is interesting to note that only the Agriculture and Communications and Transportation sectors sell more than one-half of their total output to the businesses in the local economy (57 and 69 percent, respectively). Most of Agriculture's local sales (95 percent) are to itself and Manufacturing and Processing; the Lumber sector purchases almost 62 percent of Communications and Transportation interindustry sales. This is primarily due to the use of transportation facilities for shipping lumber and wood products out of the county.

Five sectors sell less than 10 percent of their total output to the sectors of the local economy (see Table 10). They are: Lodging (0.33 percent), Cafes and Taverns (0.60 percent), Professional Services (3.83 percent), Grocery (5.52 percent), and Resorts and Marinas (0.93 percent).

Table 9. Direct Coefficients Matrix, Klamath County, 1968

SELLING SECTOR	PURCHASING SECTOR 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Agriculture.......	.2145235	.0541127	0	.4095844	0	.0054769	0	0	.0008005	0	0	0	0	.0066699	0	0	.0000548
2. Agric. Services...	.1540545	.0182977	.0004619	.0087807	.0007046	.0004716	0	.0006706	.0002068	0	.0027971	.0004057	0	0	.0086761	.0001529	.0061895
3. Lumber............	.0026222	0	.1137430	.0061852	0	0	.0001830	.0228384	0	.0120870	.0001820	0	0	.0003325	0	0	0
4. Manufacturing & Processing......	.0058472	.0000182	.0018617	.0000057	.0188407	.1113510	0	.0157952	.0017970	.0078912	.0012742	.0000479	0	.1615655	.0374963	0	.0237040
5. Lodging...........	0	0	.0000018	0	0	0	0	.0003481	.0000293	0	.0000107	0	.0010795	0	0	.0000072	.0000363
6. Cafes & Taverns...	0	.0000496	.0002331	.0000158	0	0	0	.0009698	0	0	0	0	.0000604	0	0	0	.0000654
7. Service Stations..	.0322691	.0074740	.0082637	.0064210	.0108871	.0086890	.1028092	.0234820	.0035185	.0044844	.0057526	.0120488	.0002445	.0014430	.1311882	.0020521	.0121899
8. Construction......	.0060485	0	.0032604	.0098342	.0075774	.0160701	.0026576	.1189359	.0019020	.0194974	.0140374	.0002456	.0072518	.0009029	.0021342	.0011785	.0426874
9. Professional Services........	.0045879	.0013681	.0004858	.0010641	.0028599	.0010932	.0009287	.0019959	.0005697	.0003736	.0046699	.0006469	.0017290	.0004641	.0025126	.0009786	.0087201
10. Product-Oriented..	.0318111	.0333225	.0245554	.0270465	.1787581	.2894551	.0211160	.0521561	.0176928	.0208713	.0494391	.0080421	.0285294	.0724594	.0907160	.0112363	.0590806
11. Service-Oriented..	.0149091	.0051041	.0021204	.0020055	.0374578	.0313445	.0060842	.0156754	.0090787	.0053941	.0515277	.0005024	.0501277	.0045806	.0327138	.0127375	.0237012
12. Communications & Transportation..	.0084421	.0682645	.1613647	.1115995	.0766000	.0084104	.0089191	.0172840	.0156299	.0396769	.0257284	.0033210	.0178865	.0178337	0	.0091382	.0077579
13. Financial.........	.0230436	.0115460	.0077651	.0063175	.0222967	.0025868	.0029653	.0079256	.0040125	.0017114	.0029308	.0005513	.0106717	.0006948	.0237859	.0217047	0
14. Grocery...........	.0009011	0	.0006067	0	0	.0269123	0	0	0	.0001717	0	.0006252	0	.0419426	0	0	.0032325
15. Resorts & Marinas.........	.0001560	0	0	0	0	0	0	0	0	0	0	0	0	0	.0021342	0	.0000401
16. Automotive........	.0075415	.0069620	.0125246	.0029208	0	0	.0198870	.0103490	.0039508	.0093467	.0077758	.0030664	.0007480	.0002876	.0173536	.0543582	.0259638
17. Local Gov't.......	.0472506	.0036119	.0150783	.0041350	.0222105	.0063460	.0030832	.0037769	.0053372	.0207205	.0180357	.0269524	.0069547	.0023593	.0417669	.0030266	.0056676
18. Summation[a/].......	.5540078	.2101313	.3523266	.5959160	.3781929	.5082068	.1686333	.2922030	.0645257	.1422302	.1841608	.0564557	.1252831	.3115359	.3904757	.1165707	.2190911
19. Households........	.3337123	.1048810	.2853242	.1546968	.3675640	.3423530	.1520755	.2557389	.5527168	.1786292	.3703383	.2881784	.2509756	.0995215	.1550822	.1674407	.6399147
20. Imports...........	.0020977	.6472559	.1958690	.1960159	.1159689	.0532527	.6272337	.3966703	.2786876	.5700667	.3602376	.4496803	.5517197	.5577133	.3992442	.6654813	.0685791
21. Government.... ...	.0198452	.0117208	.1023003	.0278680	.0316050	.0506385	.0347320	.0270772	.0514301	.0909371	.0556542	.1233446	.0478354	.0200398	.0312953	.0189422	.0724151
22. Depreciation & Negative Inventory Changes....	.0903370	.0260110	.0641799	.0255033	.1066693	.0455490	.0173256	.0283106	.0526398	.0181367	.0296090	.0823409	.0241862	.0111896	.0239026	.0315651	0

[a/] May not sum, due to rounding error.

Table 10. Distribution of Sales of Each Sector in the Klamath County Economy

Sector	Interindustry sales	Sales to final demand	Percent of sales sold to local economy	Percent of sales sold to final demand
1. Agriculture................ ..	$16,484,515	$12,369,200	57.13	42.87
2. Agricultural Services........	5,050,809	6,068,819	45.47	54.53
3. Lumber......................	10,311,758	69,507,488	12.92	87.08
4. Manufacturing & Processing...	6,064,412	17,091,036	26.19	73.81
5. Lodging.....................	14,407	4,311,338	0.33	99.67
6. Cafes & Taverns.............	38,804	6,424,758	0.60	99.40
7. Service Stations............	5,100,946	11,292,742	31.12	68.88
8. Construction................	4,906,159	13,707,191	26.36	73.64
9. Professional Services........	563,723	14,176,275	3.83	96.17
10. Product-Oriented............	13,132,289	34,431,310	27.61	72.39
11. Service-Oriented............	3,718,892	12,761,510	22.57	77.43
12. Communications & Transportation..............	20,765,067	9,267,485	69.16	30.86
13. Financial...................	2,605,379	3,473,132	42.86	57.14
14. Grocery.....................	1,327,255	22,733,102	5.52	94.48
15. Resorts & Marinas...........	6,530	696,323	0.93	99.07
16. Automotive..................	8,054,992	15,880,679	40.40	59.60
17. Local Government............	5,395,930	7,833,912	40.79	59.21

The reason for the low percentages is that each of these sectors primarily serves the needs of the Household sector, which is exogenous in this model.

As mentioned earlier, Row 18 of the direct coefficients matrix (Table 9) indicates the value of each sector's purchases, per dollar of sales, that are obtained from the local economy. Only three sectors purchase more than one-half of their goods and services from the local economy. They are: Agriculture (55.4 percent); Manufacturing and Processing (59.6 percent); and Cafes and Taverns (50.8 percent). The Communications and Transportation sector is least dependent upon the local economy, as it purchases only 5.6 cents worth of goods and services, per dollar of output, from local businesses.

In absolute terms (Table 8), Lumber purchases more goods and services ($28,122,000) from the Klamath County economy than any of the other sectors. Agriculture ranks second ($15,985,000), followed by Manufacturing and Processing ($13,799,000). This gives some indication of the importance of these sectors in the economy.

The Household coefficients (a_{hj}'s) in Row 19 of the direct coefficients matrix are important because they indicate the amount household incomes will rise if the output of Sector j increases one dollar. They represent the direct effect a one-dollar change in output will have upon household incomes. It is interesting to note that the Local Government sector has the largest a_{hj} (.64) in the economy. This indicates that payrolls and other payments to households account for a large portion of the budgets of the various units of local government. The Professional Services and Service-Oriented sectors rank second and third, with a_{hj}'s of .55 and .37 respectively. One would expect the service sectors to have larger household coefficients, since they are labor-intensive industries. Grocery and Agricultural Services have the smallest household coefficients, .0995 and .1049 respectively.

As noticed earlier, the large quantity of imports (Row 20 of Tables 8 and 9) purchased by the various sectors in the model indicates that the economy is highly dependent upon the "rest of the world" as a source of goods and services. The large importers are those sectors that deal in products that cannot be produced within the economy. They include Agricultural Services (64 percent of purchases are imports), Product-Oriented (57 percent), Service Stations (62 percent), Grocery (56 percent), and Automotive (67 percent). Agriculture imports less, in absolute and relative terms, than any other sector.

A final characteristic of the Klamath County economy can be seen by studying the Export column (20) in Table 8. The fact that all of the sectors (except Local Government) export some goods and services illustrates that the economy serves as a trading center for other communities outside the county. This is especially true at the wholesale trade level. The largest exporters are the basic industries of the economy. Agriculture exports more than $12 million, Lumber $66.8 million, and Manufacturing and Processing about $11.6 million. A large portion of the exports of the latter sector are agricultural commodities that have been processed by local firms.

The foregoing discussion illustrates that, like most small regional economies, the Klamath County economy is highly specialized. Lumber and Agriculture are the basic industries of the economy. Many of the goods and services used in the economy must be imported, while the primary industries export large quantities of products.

SECTION IX

APPLICATION OF THE INPUT-OUTPUT MODEL

The Direct and Indirect Coefficients Matrix

The $(I-A)^{-1}$ or direct and indirect coefficients matrix is presented in Table 11. It contains 17 rows and 17 columns, one for each of the 17 sectors of the economy. Because of the direct and indirect effects explained in Section VII, the coefficients in the $(I-A)^{-1}$ matrix are larger than those in the corresponding cells of the direct coefficients matrix. That is, the coefficients in the $(I-A)^{-1}$ matrix indicate the total increase in output of a sector resulting from a change in demand for the output of a sector. For example, assume that there is a one-dollar increase in final demand for the products of Agriculture. This sets into motion a series of changes in the output of all the sectors of the economy. When the change has worked itself out, Agriculture's output will have increased \$1.29; Agricultural Services, 20 cents; Lumber, one-half cent; and Manufacturing and Processing one cent, and so on (reading down the Agriculture column).

Output Multiplier

The eighteenth row of the $(I-A)^{-1}$ matrix is the sum of the first 17 rows of each column. The figures in the row represent the change in total output of the economy resulting from a one-dollar change in final demand of the sector listed at the top of the column. For example, a one-dollar increase in final demand of Agriculture will cause the output of the entire economy to increase \$1.82. This is called the output multiplier of the sector. The magnitude of the output multiplier of each sector depends upon the quantity of goods and services the sector purchases from the local economy. Earlier it was pointed out that Communications and Transportation purchased only 5.6 percent of its purchases from the local economy. The output multiplier of that sector is small (1.07), as would be expected. Conversely, Manufacturing and Processing purchases more of its goods and services from the local economy than other sectors, and the output multiplier of the sector is the largest (1.96) in the economy. The output multiplier for each sector is listed in Column 2 of Table 12.

Income-Output Coefficients

Another useful tool is the "income-output" coefficient (H_k) listed in Column 3 of Table 12. These coefficients are computed as follows:

$$H_k = \sum_{i=j=1}^{17} a_{19_j} \, r_{ik} \qquad (69)$$

Table 11. Direct and Indirect Coefficients Matrix, Klamath County, 1968

	PURCHASING SECTOR																
SELLING SECTOR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Agriculture........	1.2924189	.0715281	.0017655	.5303589	.0114250	.0705473	.0002174	.0100951	.0022119	.0048521	.0016276	.0005500	.0004275	.0988687	.0217108	.0001674	.0142783
2. Agric Services....	.2034219	1.0299960	.0010798	.0925499	.0030697	.0128891	.0001018	.0026726	.0006590	.0010560	.0034530	.0006905	.0003060	.0171587	.0130502	.0002722	.0089656
3. Lumber.............	.0050732	.0008269	1.1289852	.0098114	.0031961	.0060240	.0006957	.0303902	.0003767	.0146981	.0015116	.0002068	.0007493	.0032411	.0020454	.0002621	.0024848
4. Manufacturing & Processing.......	.0101022	.0010847	.0032194	1.0048381	.0214898	.1197486	.0004001	.0189837	.0021972	.0091556	.0026500	.0009458	.0007721	.1703329	.0398947	.0002817	.0259868
5. Lodging............	.0000440	.0000166	.0000156	.0000303	1.0000328	.0000180	.0000063	.0004051	.0000355	.0000123	.0000224	.0000026	.0010962	.0000079	.0000340	.0000340	.0000574
6. Cafes & Taverns....	.0000316	.0000550	.0002715	.0000441	.0000198	1.0000333	.0000049	.0011121	.0000039	.0000288	.0000209	.0000038	.0000720	.0000115	.0000152	.0000041	.0001174
7. Service Stations...	.0505540	.0126468	.0137084	.0302422	.0160474	.0166331	1.1151830	.0316320	.0046137	.0071525	.0084350	.0140276	.0015610	.0080539	.1496507	.0028894	.0167171
8. Construction.......	.0143484	.0022169	.0063512	.0183536	.0155495	.0286043	.0043592	1.1378045	.0031860	.0242193	.0192585	.0019486	.0104380	.0063725	.0089977	.0024012	.0513798
9. Professional Services.........	.0071093	.0019811	.0009765	.0042238	.0036325	.0021509	.0011723	.0026343	1.0007314	.0007632	.0052421	.0009295	.0021429	.0013759	.0035552	.0012092	.0092312
10. Product-Oriented...	.0581251	.0400509	.0329186	.0547837	.1904989	.3094692	.0255200	.0657223	.0197731	1.0259884	.0567059	.0106190	.0338895	.0880268	.1049830	.0142184	.0679513
11. Service-Oriented...	.0260502	.0082094	.0043800	.0140249	.0433469	.0378958	.0080439	.0207097	.0152899	.0073289	1.0560206	.0015324	.0541728	.0083292	.0347294	.0157132	.0275269
12. Communications & Transportation...	.0319157	.0738215	.1854346	.1288916	.0899685	.0391008	.0117901	.0309500	.0173916	.0453898	.0311355	1.0044428	.0215342	.0444174	.0137089	.0113082	.0168817
13. Financial..........	.0334278	.0141072	.0095785	.0206359	.0237899	.0063267	.0039979	.0103770	.0043564	.0026005	.0037810	.0007713	1.0112100	.0047084	.0264103	.0233338	.0019919
14. Grocery............	.0014715	.0001595	.0009295	.0007187	.0002092	.0283062	.0000286	.0001196	.0000397	.0003072	.0001061	.0007512	.0000550	1.0439570	.0002099	.0000249	.0034470
15. Resorts & Marinas..........	.0002046	.0000116	.0000012	.0000843	.0000030	.0000118	.0000002	.0000019	.0000006	.0000017	.0000011	.0000012	.0000004	.0000159	1.0021440	.0000002	.0000428
16. Automotive.........	.0158705	.0094640	.0169545	.0110564	.0041341	.0058081	.0240042	.0148427	.0048693	.0110814	.0104146	.0044683	.0020837	.0034427	.0248025	1.0580259	.0299144
17. Local Gov't........	.0653672	.0103294	.0232081	.0351263	.0305327	.0188689	.0046023	.0051818	.0066366	.0234121	.0214906	.0275880	.0094686	.0112854	.0474299	.0043110	1.0093432
18. Summation a/	1.8155362	1.2765056	1.4297781	1.9557740	1.4569958	1.7024360	1.2001299	1.3866376	1.0773725	1.1786482	1.2218764	1.0694795	1.1499592	1.5096049	1.4983721	1.1344570	1.2863176

a/ May not sum, due to rounding error.

Table 12. Output and Income Multipliers and Income-Output Coefficients for Each Sector of the Klamath County Economy

(1) Sector	(2) Output multiplier	(3) Income-Output coefficients	(4) Income multiplier
1. Agriculture	1.82	.55	1.66
2. Agricultural Services	1.28	.18	1.71
3. Lumber	1.43	.41	1.43
4. Manufacturing & Processing	1.96	.43	2.83
5. Lodging	1.47	.49	1.32
6. Cafes & Taverns	1.70	.50	1.45
7. Service Stations	1.20	.19	1.25
8. Construction	1.39	.35	1.38
9. Professional Services	1.08	.57	1.04
10. Product-Oriented	1.18	.23	1.30
11. Service-Oriented	1.22	.44	1.18
12. Communications & Transportation	1.07	.31	1.09
13. Financial	1.15	.30	1.19
14. Grocery	1.51	.21	2.11
15. Resorts & Marinas	1.50	.28	1.78
16. Automotive	1.13	.20	1.19
17. Local Government	1.29	.71	1.11

where a_{19_j} = the value of purchased labor services from the Household sector by the j^{th} sector, per dollar of total output in the j^{th} sector; that is, it is the a_{hj} row ($j = 1, 2, \cdots, 17$) in the direct coefficients matrix.

r_{ik} = the elements of the k^{th} column of the $(I-A)^{-1}$ matrix.

For example, the income-output coefficient for the Agriculture sector (H_1) is calculated as follows:

$$H_1 = a_{19_1} (r_{11}) + a_{19_2} (r_{21}) + a_{19_3} (r_{31}) + \cdots + a_{19_{17}} (r_{17_1})$$

$$= .3337 (1.2924) + .1049 (.2034) + .2853 (.0051) + \cdots + .6399 (.0654)$$

$$= .55.$$

The income-output coefficient of the k^{th} sector measures the total change in county household income (that amount paid to households by all 17 sectors) resulting from a one-dollar change in the output of the k^{th} sector. Again using Agriculture as an example, a one-dollar increase in the sales of Agriculture will cause a 55-cent increase in household income in the county.

Income Multiplier

Another multiplier that is often computed is the "income multiplier" (M_k) of a sector. It is calculated by dividing the income-output coefficient by the household coefficient of the sector:

$$M_k = \frac{\sum_{i=j=1}^{17} a_{19_j} \; r_{ik}}{a_{19_k}} \qquad (70)$$

Thus, the income multiplier is the ratio of the direct and indirect changes in income to the direct change in income. It measures the change in county household income resulting from a one-dollar change in the income of households in the k^{th} sector. The income multipliers for the 17 sectors are listed in Column 4 of Table 12. If households were endogenous in the model, the income multiplier would be larger. It would represent the ratio of direct, indirect, and induced changes in income to the direct change in income.

The income multipliers can be misleading because of the large weighting factor given to the a_{hj} of the sector. Since the a_{hj} is the denominator in the calculations, it has a large influence upon the magnitude of the multiplier. A small a_{hj} will lead to a larger multiplier than will a large a_{hj}, given that the numerator is held constant. Thus, caution must be exercised when interpreting the income multipliers.

In some cases the income-output coefficients are easier to interpret because the total change in income is related to a change in final demand and not to a change in income as in the income multiplier. The income-output coefficient makes it obvious how much income will rise as output increases. One does not have to be concerned with the amount the output of a sector must increase to obtain the desired one-dollar change in income for that sector.

Estimation of Recreational Expenditures

To estimate the local benefits attributable to recreational activities at Klamath Lake as it exists at the present time, the quantity of recreational expenditures that were made in the county during 1968 had to be estimated. The data collected from recreationists at Klamath Lake, to estimate the recreational demand model for the lake, were also used to determine the type and magnitude of recreational expenditures made in Klamath County. Only those questionnaires completed by recreationists who stayed at Klamath Lake less than 20 days were used. There are 43 such questionnaires.

Travel Cost

The relevant travel cost for this analysis is all purchases made in Klamath County by recreationists while traveling to and from Klamath Lake during 1968. Travel cost is composed of six categories: Automobile, Cafes and Taverns, Grocery, Lodging, Camping, and "Other" costs.

To estimate the travel costs incurred in Klamath County, the 43 questionnaires were put into one of two groups. The first contains those recreationists who were residents of the county, while the second included the non-Klamath County residents. The first group contains 29 of the 43 observations. It is assumed that all travel costs incurred by the first group were spent in the county, since the origin and destination were both in the same county. Automobile expenses for this group were computed by multiplying the number of miles traveled to and from the site by an average cost per mile of five cents. All other components of travel cost were estimated from data contained in the questionnaire. All components of travel cost for the resident group were divided by the number of people in the party to obtain the desired estimate of average travel cost per person.

A different procedure had to be developed for the non-resident group. It could not be assumed that all expenditures associated with traveling to and from the site would be made in Klamath County. However, since the questionnaire indicated where the recreationists came from, it was possible to estimate the total miles traveled in the county. The number of miles traveled inside the county was then multiplied by 5 cents to estimate automobile travel expenses incurred within the county.

An additional step was required to estimate the other five components of travel cost for the non-resident group. The number of miles traveled in Klamath County was divided by the total miles traveled during the trip to obtain the percent of the total distance that was traveled within the county. These percentages were then applied to the other components of travel cost to estimate the amount that was spent in the local economy. That is, if the distance traveled inside Klamath County was 10 percent of the total distance, it was assumed that 10 percent of the total expenditures for food, lodging, and so forth was made inside Klamath County. It was again necessary to divide these estimates by the number of people in the party, to obtain the average travel cost per person. Table 13, Column 2, shows the average amount per person spent inside the county for each of the components of travel cost.

Table 13. Average and Total Travel Cost Incurred in Klamath County, by Component, in 1968

(1) Component	(2) Average travel cost	(3) Total travel cost
Automobile	$ .6371	$ 93,329
Cafes	.1088	15,938
Grocery	.6360	93,168
Lodging	.2477	36,286
Camping	.0458	6,709
Other	.1242	18,194
TOTAL	$1.7996	$263,624

It should be emphasized that the average travel cost computed here is not the same as that computed earlier. The previous estimate ($6.84) is larger than the one computed here ($1.80). The primary reason for the difference is that the estimate used here represents only those travel costs incurred in Klamath County, while the other figure represents total travel expenditures, without geographical reference.

The estimated average travel cost incurred in Klamath County was multiplied by the number of people visiting the site in 1968, to estimate the total amount of travel expenditures made in the county during the year. The U.S. Forest Service estimates that 146,491 people visited Klamath Lake in 1968. Therefore, recreationists spent an estimated $263,624 (146,491 x $1.7996) in Klamath County while traveling to and from Klamath Lake. A breakdown of this cost into its components is given in Column 3 of Table 13.

On-Site Costs

An estimate of the average on-site cost per person per day was computed in a manner similar to the travel costs discussed in the previous section.

Since it can be assumed that all on-site purchases were made in the county, it was not necessary to separate the observations into the local- and non-local-resident groups.

There is one difference between estimating travel costs and estimating on-site costs. Travel costs are estimated on a per-person basis, while on-site costs are estimated on a per-person per-day basis. That is, the various components of on-site cost are divided by the number of visitor-days the party stayed at the lake. On-site costs are computed in this manner because it is hypothesized that the average number of days spent at the site during each visit will increase as the water quality of the lake improves. This point will be expanded upon later. Column 2 of Table 14 shows the average daily cost per person for each component of on-site costs.

Table 14. Average and Total On-Site Cost, by Component, for Klamath Lake in 1968

(1) Component	(2) Average on-site cost/day	(3) Total on-site cost
Cafes..................	$ .2132	$ 61,527
Grocery...............	.2985	86,143
Lodging...............	.3360	96,965
Camping...............	.0209	6,032
Automobile............	.0517	14,920
Boat..................	1.0473	302,237
Bait..................	.0169	4,877
Rentals...............	.0266	7,676
TOTAL......	$2.0111	$580,377

The number of visitor-days enjoyed at Klamath Lake in 1968 is estimated by multiplying the number of visits (146,491) by the average length of stay per visit (1.97), as estimated in the demand model. This gives 288,587 visitor-days. An estimate of total on-site costs for Klamath Lake in 1968 is obtained by multiplying the number of visitor-days by the on-site cost per visitor-day. Total on-site costs are estimated to be $580,377. Total on-site cost is allocated among its components in Column 3 of Table 14. The average on-site cost per day in Table 14 is greater than the value used in the demand model, because an adjustment was not made for food costs the recreationists would have incurred if they had stayed at home.

On-site costs and travel costs are aggregated to obtain the total expenditures in Klamath County associated with recreation at Klamath Lake in 1968. Thus, $844,001 represents the total annual cost incurred in Klamath County by recreationists at Klamath Lake in 1968, given the present water quality of the lake. Table 15 shows how much of the total figure was spent in the various sectors of the economy. This was determined by assigning each component of travel cost and on-site cost to the appropriate sector of the model.

Table 15. Total Recreational Expenditures and Percentages, in Klamath County, by Sector, Associated with Recreation at Klamath Lake in 1968

(1) Sector	(2) Expenditures	(3) Percent of total recreational expenditures
Service Stations.........	$403,658	48.21
Cafes & Taverns..........	75,859	9.06
Grocery..................	187,302	22.37
Lodging..................	132,292	15.80
Resorts & Marinas........	12,811	1.53
Product-Oriented.........	25,370	3.03
TOTAL........	$837,292	100.00

It should be noted that the total estimated in Table 15 ($837,292) does not equal the sum of the totals in Tables 13 and 14 ($844,001). The difference ($6,709) is due to camping fees incurred in Klamath County while traveling to and from Klamath Lake. It is assumed that these camping fees were paid to the state or federal government, and not to any of the sectors of the local economy. However, camping fees incurred while at the site were allocated to the Resorts and Marinas sector, since all camping facilities at the site are privately owned.

Note that only six sectors of the economy are directly affected by recreational expenditures. Column 3 of Table 15 shows the percentage of the recreational expenditures that each of the six sectors received. The

Service Stations sector received almost half of the total recreational expenditures made in the county.

The Impact of Recreational Expenditures in 1968

Input-output projections are based on Equation (68). The first step is to project a new level of final demand that is expected to occur due to an exogenous force acting upon the economy. The new "projected" level final demand is post-multiplied with the R matrix to obtain the new projected total output of each sector:

$$\hat{X} = (R)(\hat{Y})$$

where $\hat{Y}$ = projected final demand vector,

$\hat{X}$ = projected total output vector,

$R = (I-A)^{-1}$ matrix.

The expenditures that recreationists at Klamath Lake made in 1968 are viewed as a change in final demand in the input-output model. The increase in recreational expenditures are multiplied through the model to estimate the total effect of recreational expenditures associated with Klamath Lake in 1968. The projected increase in final demand is listed in Column 2 of Table 16, while the projected total output is listed in Column 3 of Table 16.

Although only six sectors are directly affected by recreational expenditures, all sectors in the economy are indirectly affected. This provides an illustration of the importance of the from-to model in the study. If the relationships between the various sectors of the economy had not been specified, the total effect of the recreational expenditures would have been underestimated.

The increase in household income resulting from recreational expenditures at Klamath Lake is also estimated. Earlier it was noted that the a_{hj}'s of the direct coefficients matrix specify the amount that household incomes of that sector will increase if the output of the sector increases by one dollar. Therefore, the increase in household income is determined by multiplying the estimated increase in output of a sector by the a_{hj} of that sector. The results are listed in Column 4 of Table 16. It is estimated that county household income in 1968 was $227,000 higher as a result of the recreational activities at Klamath Lake.

Table 16. Projected Increases in Final Demand, Total Output, and County Household Income, by Economic Sector, Associated with Recreation at Klamath Lake in 1968

(1)	(2)	(3)	(4)
Sector	Projected final demand ($\hat{Y}$)	Projected total output ($\hat{X}$)	Projected increase in household income
1. Agriculture.......	$ 0	$ 25,870	$ 8,633
2. Agric. Services...	0	4,832	507
3. Lumber...........	0	2,167	618
4. Manufacturing & Processing.....	0	44,736	6,921
5. Lodging..........	132,292	132,302	48,629
6. Cafes & Taverns...	75,859	75,869	25,974
7. Service Stations..	403,658	457,144	69,520
8. Construction......	0	7,916	2,024
9. Professional Services.......	0	1,440	796
10. Product-Oriented..	25,370	102,841	18,370
11. Service-Oriented..	0	14,111	5,226
12. Communications & Transportation.	0	29,275	8,437
13. Financial.........	0	6,527	1,637
14. Grocery...........	187,302	197,732	19,674
15. Resorts & Marinas........	12,811	12,843	1,992
16. Automotive........	0	11,936	1,998
17. Local Gov't.......	0	10,644	6,811
TOTAL......	$837,292	$1,138,185	$227,767

SECTION X

ECONOMIC BENEFITS OF WATER QUALITY IMPROVEMENT

In Section VI the demand model for Klamath Lake was estimated for the existing water quality regime. The net economic value of the lake in 1968 was estimated to be about $82,000. The regional benefits associated with recreation at Klamath Lake in 1968 were also estimated by using the input-output model of Klamath County. Household income in the county increased an estimated $227,000 as a result of recreation at Klamath Lake in 1968. Now consider the effects of improving the characteristics of Klamath Lake.

An Improvement in Water Quality

A possible improvement in the water quality of Klamath Lake might consist of two steps. The first step would be the removal of the blue-green algae, while the second would be decreasing the water temperature and improving the beaches around the lake.

It is hypothesized that the proposed improvements will affect the use-intensity ratings of the lake, since the lake would be better suited for the various recreational activities. For example, the removal of algae (Step 1) would increase the use of the lake for boating and water-skiing, while lower water temperatures and improved beaches would increase swimming and fishing at the lake. Table 17 shows the hypothesized use-intensity ratings associated with Steps 1 and 2 described above. The use-intensity ratings for Steps 1 and 2 were estimated by personnel at the E.P.A. Pacific Northwest Water Laboratory in Corvallis, Oregon.

Table 17. Hypothesized Use-Intensity Ratings for Klamath Lake at the Present Time, and after Steps 1 and 2

Activity	Klamath Lake Use-Intensity Ratings		
	Present	Step 1	Step 2
Swimming	0	1	3
Boating	1	3	3
Water Skiing	1	3	3
Fishing	1	2	3

One other possibility has to be considered: Will improvements in water quality affect any of the other variables in the demand model? That is, will the average on-site cost, travel cost, or income of recreationists change as the characteristics of the site improve? To determine this, the average values of p_1, k, and y for each lake were computed and regressed against the site characteristics. The site characteristics were represented by summing the swimming, boating, water skiing, and fishing use-intensities for each lake. The three equations are:

$$p_1 = 1.638 + \underset{(.046)}{.066Q} \qquad R^2 = .507 \qquad (71)$$

$$k = 12.075 + \underset{(.323)}{.475Q} \qquad R^2 = .519 \qquad (72)$$

$$y = 5{,}031.295 + \underset{(220.150)}{529.637Q} \qquad R^2 = .743 \qquad (73)$$

where Q represents the sum of the use-intensities of each lake.

The sample data suggests that the average values of p_1, k, and y increase as the sum of the use-intensities of a lake increase. However, the R^2 for each equation, and the coefficients of Q in each of the three equations, are not significant at the 10 percent level. Therefore, no relationships between Q and the p_1, k, and y variables are assumed to exist. Any improvements of water quality will enter the demand model only through the W and F variables.

Demand Model for Klamath Lake (Step 1)

After removal of the algae from Klamath Lake, the estimated demand model is:

$$k^* = 44.151 + .002y + 10.435p_1 \qquad (74)$$

$$p_1^* = 10.060 + .269k - .004k^2 + .000000017y^2 \qquad (75)$$

$$q_1 = e^{.759 - .0064k^* + .0064k + .0637p_1^* - .0637p_1} \qquad (76)$$

The estimated average critical travel cost and average critical on-site costs are \$90.38 and \$12.07, respectively. Introducing these averages into the q_1 relation, and holding k at the average value estimated prior to Step 1, the demand function is estimated to be:

$$q_1 = e^{.993 - .0637p_1} \qquad (77)$$

The difference between this demand function and one previously derived for Klamath Lake is the larger constant term. Thus the demand curve has shifted to the right, indicating that the length of stay per visit has increased. The demand curve is presented graphically in Figure 13. The average length of stay per visit has increased from 1.97 to 2.41 days. Note that the average on-site cost is the same value that was used in the previous demand model for Klamath Lake.

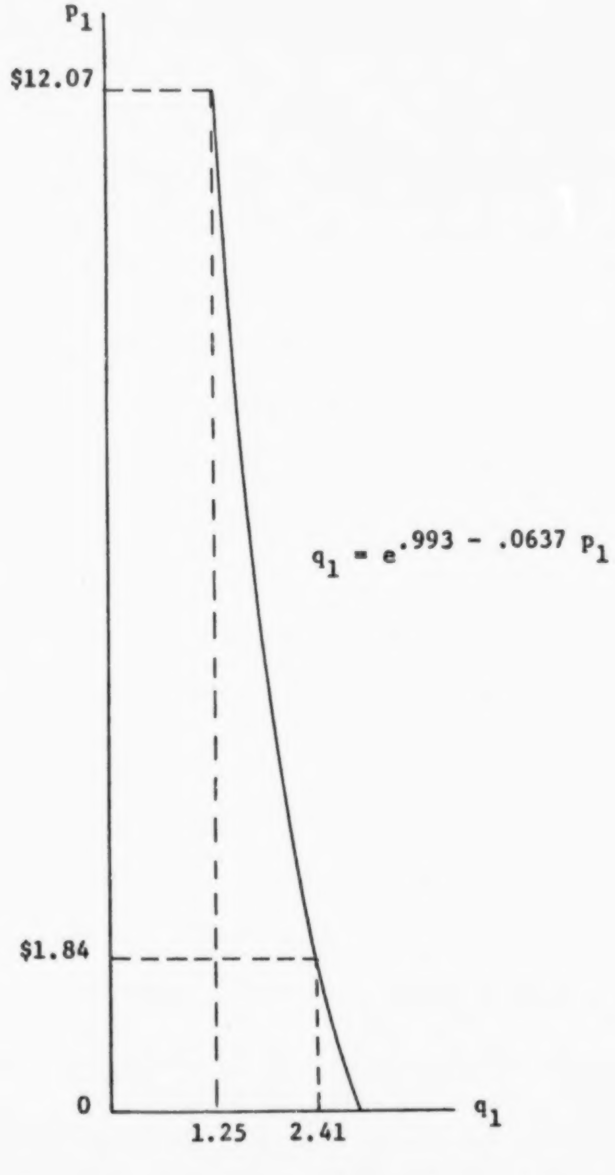

Figure 13. The Average Recreationist's Demand Curve, Per Visit, for Klamath Lake (Step 1).

The value per visit is estimated to be:

$$\text{Value per visit} = \int_{1.84}^{12.07} (e^{.993 - .0637p_1})\, dp_1 - [(10.23)(1.25)] \quad (78)$$

$$= \$18.29 - \$12.79 = \$5.50.$$

Before the net economic value of Klamath Lake, after Step 1, can be determined it is necessary to estimate the number of visits to Klamath Lake after the algae has been removed. Substituting the larger values of W and F into the visits equation gives an estimate of 234,386 visits. This represents a 60 percent increase in the number of visits.

The estimated net economic value of Klamath Lake, after removing the algae, is:

$$(\$5.50)(234{,}386) = \$1{,}289{,}123.$$

The estimated value of Klamath Lake as it now exists is $82,035. The value of removing the algae is represented by the difference in the two estimated values, or $1,207,088. That is, based on 1968 data, $1.2 million worth of recreational benefits could be obtained per year by removing the algae from Klamath Lake.

Demand Model for Klamath Lake (Step 2)

It is hypothesized that lowering the water temperature of the lake and improving the beaches would cause the swimming use-intensity to rise from low to high, and the fishing use-intensity to increase from medium to high. Again, it is assumed that all other variables are unaffected by the proposed improvements. Substituting the higher use-intensity ratings into the model yields the following demand model for Klamath Lake after Step 2:

$$k^* = 60.426 + .002y + 10.435p_1 \quad (79)$$

$$p_1^* = 14.250 + .269k - .004k^2 + .000000017y^2 \quad (80)$$

$$q_1 = e^{.759 - .0064k^* + .0064k + .0637p_1^* - .0637p_1} \quad (81)$$

The k^* and p_1^* functions have again shifted, representing an increase in the average k^* and p_1^* for recreationists at Klamath Lake. The revised averages are $106.65 and $16.26 respectively. The proposed revised demand function is:

$$q_1 = e^{1.156 - .0637p_1} \quad (82)$$

The demand function has again shifted to the right, since the constant term is larger.

The value per visit to recreationists at Klamath Lake after Step 2 is seen more clearly with the use of Figure 14. The per-visit value is:

$$\text{Value per visit} = \int_{1.84}^{16.26} (e^{1.156 - .0637p_1})\, dp_1 - [(14.42)(1.13)] \quad (83)$$

$$= \$26.72 - \$16.30 = \$10.42.$$

When the higher use-intensity ratings are substituted into the visits equation, the number of visits to Klamath Lake after Step 2 is estimated to be 377,947, a 158 percent increase above the number of visits estimated for Klamath Lake in 1968. The estimated net economic value of Klamath Lake after the completion of Step 2 is:

$$(\$10.42)(377{,}947) = \$3{,}938{,}208$$

The total increase in economic value of Klamath Lake after completion of Steps 1 and 2 is $3,856,173. That is, the recreational benefits available to society would be worth $3.86 million annually if the two-step improvement in Klamath Lake were undertaken. $1.2 million worth of benefits would be associated with the first step. An additional $2.66 million are related to the second step.

Increase in Recreational Expenditures

The demand estimates of the number of visits and the length of stay per visit are used to estimate the net increase in expenditures associated with recreation at Klamath Lake as water quality improves. The net increase in travel costs is estimated by multiplying the averages in Table 13 by the net increase in the number of visits to the site resulting from water quality improvements. That is, upon completion of Step 1, the estimated number of visits to the lake would increase from 146,491 to 234,947. Therefore, the net increase is 87,895 visits. This figure is multiplied by the averages in Table 13 to obtain the estimates in Column 2 of Table 18. The same procedure is used to estimate the net increase in expenditures associated with Step 2 (Column 3, Table 18). (See page 90 for an explanation of the deletion of camping fees in Table 18.)

The net increase in on-site costs was estimated in the same manner. The net increase in visitor-days associated with Step 1 is the difference between the number of visitor-days estimated after the completion of Step 1 and the number of visitor-days estimated for 1968:

$$\begin{aligned}\text{Net visitor-days (Step 1)} &= (234{,}386)(2.41) - (146{,}491)(1.97) \quad (84)\\ &= 564{,}870 - 288{,}587\\ &= 276{,}283 \text{ visitor-days.}\end{aligned}$$

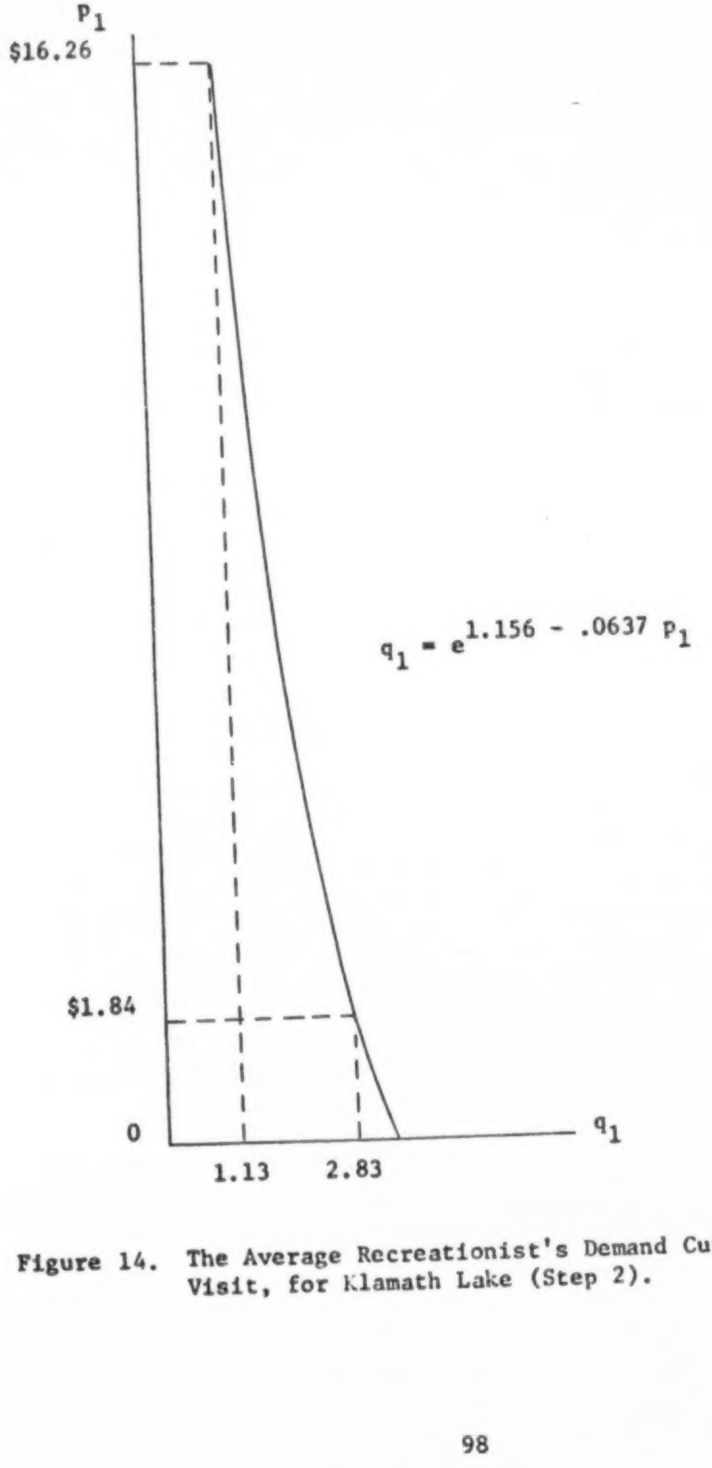

Figure 14. The Average Recreationist's Demand Curve, Per Visit, for Klamath Lake (Step 2).

Table 18. Net Increase in Expenditures, for Each Component of Travel Cost, Associated with Improvements of Water Quality at Klamath Lake

(1) Component	(2) Net Increase in Expenditures Step 1	(3) Step 2
Automobile	$ 55,998	$147,461
Cafes	9,563	25,183
Grocery	55,901	147,206
Lodging	21,771	57,331
Other	10,964	28,823
TOTAL	$154,197	$406,004

Completion of Step 2 would result in an estimated net increase of 781,003 visitor-days. The net increases in visitor-days are multiplied by the average values of each component of on-site cost listed in Table 14, to obtain the net increase in expenditures for each component of on-site cost. The estimates for Steps 1 and 2 are listed in Table 19.

Table 19. Net Increase in Expenditures for Each Component of On-Site Cost Associated with Improvements of Water Quality at Klamath Lake

(1) Component	(2) Net Increase in Expenditures Step 1	(3) Step 2
Cafes	$ 58,904	$ 166,510
Grocery	82,470	233,129
Lodging	92,831	262,417
Camping	5,774	16,323
Automobile	14,284	40,378
Boat	289,351	817,944
Bait	4,669	13,199
Rentals	7,349	20,775
TOTAL	$555,632	$1,570,675

Impact of Recreational Expenditures (Step 1)

The increase in expenditures of recreationists represents an exogenous change in the local economy. That is, the increase in expenditures is caused by a postulated change in the recreation experience at Klamath Lake. This change does not alter the structure of the local economy. Therefore, the appropriate way to view the increase in recreational expenditures is as a change in the final demand of the model.

Column 2 of Table 20 is the projected final demand associated with the removal of the algae from Klamath Lake. The projected final demand is post-multiplied by the $(I-A)^{-1}$ matrix to determine the direct and indirect increase in sales resulting from the completion of Step 1. The projected output of each sector is listed in Column 3 of Table 20.

The total increase in output associated with Step 1 is $252,286 greater than the original value of recreational expenditures. That is, the estimated $709,829 spent in the economy by recreationists would generate an additional increase in sales of $252,286 in the economy.

As the output of the local economy increases, household incomes also rise. The exact magnitude of the increase is estimated by multiplying the change in output of each sector by the household coefficient (a_{19_j} of the direct coefficients matrix) of the sector. The results are listed in the last column of Table 20. It is estimated that household income in the county will increase $194,000 if the algae are removed from Klamath Lake.

Impact of Recreational Expenditures (Step 2)

The procedures described in the previous section are also used to estimate the regional impact associated with lowering the water temperature and improving the beaches at Klamath Lake. The results are contained in Table 21. Projected total output has increased to almost $2 million, while county household income is estimated to increase more than a half-million dollars per year if Steps 1 and 2 are completed at Klamath Lake.

The net impact associated with Step 2 can also be estimated. The change in total output of the economy would increase $1,716,439. Household income would increase an estimated $347,820 if Step 2 were undertaken after the completion of Step 1.

A Limitation Restated

While Section X has developed some very specific numerical estimates of several variables, sight must not be lost of the many limitations underlying these estimates. Many shortcomings, both in theory and empirical techniques, were discussed in the earlier sections. We hasten to reemphasize that the final estimates which have just been presented are subject to all of these shortcomings. Consequently, they are difficult to interpret.

Table 20. Projected Increases in Final Demand, Total Output, and County Household Income, by Economic Sector, Associated with Klamath Lake after the Completion of Step 1

(1)	(2)	(3)	(4)
	Klamath Lake (Step 1)		
Sector	Projected final demand ($\hat{Y}$)	Projected total output ($\hat{X}$)	Projected increase in household income
1. Agriculture..................	$ 0	$ 20,259	$ 6,760
2. Agricultural Services........	0	3,832	402
3. Lumber.......................	0	1,734	495
4. Manufacturing & Processing...	0	35,041	5,420
5. Lodging......................	114,602	114,611	42,120
6. Cafes & Taverns..............	68,467	68,476	23,443
7. Service Stations.............	359,633	407,225	61,927
8. Construction.................	0	6,692	1,711
9. Professional Services........	0	1,234	682
10. Product-Oriented............	15,633	81,795	14,609
11. Service-Oriented............	0	12,243	4,538
12. Communications & Transportation..........	0	24,264	6,993
13. Financial...................	0	5,636	1,415
14. Grocery.....................	138,371	146,433	14,570
15. Resorts & Marinas...........	13,123	13,155	2,040
16. Automotive..................	0	10,489	1,756
17. Local Government............	0	8,996	5,757
TOTAL.............	$709,829	$962,115	$194,638

The major limitation to the reliability of our estimates is probably related to the manner in which the predictions of changes in recreational use of Klamath Lake were made, given the postulated two-step improvement in water quality. It is recalled that "use-intensities" are employed in the prediction model to relate recreational demand to changes in water

Table 21. Projected Increases in Final Demand, Total Output, and County Household Income, by Economic Sector, Associated with Klamath Lake after the Completion of Step 2

(1)	(2)	(3)	(4)
	Klamath Lake (Step 2)		
Sector	Projected final demand ($\hat{Y}$)	Projected total output ($\hat{X}$)	Projected increase in household income
1. Agriculture..................	$ 0	$ 56,008	$ 18,690
2. Agricultural Services........	0	10,606	1,112
3. Lumber......................	0	4,803	1,370
4. Manufacturing & Processing...	0	96,877	14,987
5. Lodging.....................	319,748	319,773	117,548
6. Cafes & Taverns..............	191,693	191,717	65,644
7. Service Stations............	1,005,783	1,138,867	173,222
8. Construction................	0	18,631	4,764
9. Professional Services........	0	3,440	1,901
10. Product-Oriented............	42,022	226,391	40,433
11. Service-Oriented............	0	34,164	12,651
12. Communications & Transportation..........	0	67,432	19,434
13. Financial..................	0	15,720	3,946
14. Grocery.....................	380,335	402,596	40,058
15. Resorts & Marinas...........	37,098	37,187	5,767
16. Automotive..................	0	29,299	4,905
17. Local Government............	0	25,044	16,026
TOTAL...............	$1,976,679	$2,678,554	$542,458

quality. A logically superior model can be developed for relating changes in the physical characteristics of the water resource to responses in human behavior. However, the empirical specification of these relationships could not be undertaken within the scope of this study. The need for multidisciplinary research is clearly indicated in this area. Failure to focus on the logical relationships between the characteristics of the physical environment and recreational behavior by going directly to the "use-intensity" variables led to an inadequate specification of the prediction model. One might interpret these variables as proxies for the dependent variable itself. If so, one would expect the use-intensities to "explain" a considerable proportion of the variation in the dependent variable. This could lead to an overstatement of the estimated effects associated with a water quality improvement.

SECTION XI

ACKNOWLEDGMENTS

The authors wish to acknowledge the valuable assistance provided by the staff of the Pacific Northwest Water Laboratory of the Environmental Protection Agency. Their input helped in the formulation stages of the project, as well as during the actual analysis.

Appreciation is also extended to Dr. John A. Edwards, Department of Agricultural Economics, Oregon State University, for helping with the formulation of the theoretical demand model.

The Klamath County Chamber of Commerce also provided help by contacting the businesses in the county, and soliciting their support for the study.

The authors also thank Dr. Russell Youmans, Department of Agricultural Economics, Oregon State University, and Arnold Hoffman, Economist, Systems Analysis and Economics Branch, Division of Planning and Interagency Programs, for their review of the manuscript.

The financial support of the Environmental Protection Agency, and the assistance provided by Dr. Roger Don Shull, Project Officer, is also acknowledged with sincere thanks.

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SECTION XIII

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SECTION XIV

GLOSSARY

Consumer's Surplus - The difference between what a consumer actually pays for a commodity and what he would be willing to pay rather than do without it.

Critical On-Site Costs (p_1^*) - The level of on-site costs at which the recreationist is indifferent between recreating and not recreating, given the utility function of the individual, his income, travel costs, and the price of other goods. A change in any of these variables will result in a change in the value of p_1^*.

Critical Travel Costs (k^*) - The value of travel costs at which the recreationist is indifferent between recreating and not recreating, given his utility function, his income, on-site costs, and the price of other goods. A change in any of these variables will result in a change in the value of k^*.

Demand Curve - The locus of points representing the maximum amount of a commodity the consumer will purchase at different prices in a given time period, other things being equal.

Direct Coefficients (a_{ij}'s) - The value of goods and services Sector j must purchase from Sector i to produce one dollar's worth of output.

Income Multiplier (M_k) - The total change in household income of the region, resulting from a one-dollar change in income of households in the k^{th} sector.

Income-Output Coefficients (H_k) - The total change in income paid to all households in the region as a result of a one-dollar change in the output of the k^{th} sector.

Marginal Utility - The change in utility or satisfaction resulting from a one-unit change in the level of consumption of a good or service.

Output Multiplier - The total change in the output of the entire economy resulting from a one-dollar change in the output of one sector in the economy.

Recreation Visit - The entry of any person upon a site or area of land or water generally recognized as an element in the recreation population, except those which are part of, or incidental to, the pursuit of a gainful occupation.

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Recreation Visitor-Day - Twelve visitor-hours, which may be accumulated continuously, intermittently, or simultaneously by one or more persons who are not in pursuit of a gainful occupation at the recreation site.

SECTION XV

APPENDICES

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B. Input-Output Questionnaire. 123

APPENDIX A

FIELD SURVEY QUESTIONNAIRE

OREGON STATE UNIVERSITY

July, 1968

Hello, I'm ________________. I'm working on a recreation survey for Oregon State University and would like to ask you a few interesting questions if you don't mind!

1 - 1 Visit lake (continue) 2 Other purpose (DISCONTINUE)		Was the main purpose of your trip to visit this particular lake, or are you taking your trip for some other purpose?
2 - ________________ ________________ (AM or PM)	Date Time	May I ask when you arrived at this particular site--the date and the approximate time?
3 - ________________ ________________ (AM or PM)	Date Time	Now, when do you plan to leave this particular site--again the date and approximate time of day or night?
4 - ________________ ________________ ________________	City/Town County State	Where do you live at the present time--the city or town, county and state?
4a- 1 In city/town (skip to 5) 2 Suburban area (skip to 5) 3 Rural outside (ask 4b)		Do you live right in the city (town), a suburban area, or a rural area outside of the city (town)?
4b- ________________ 1 Nearer site 2 Away from site	Miles	How many miles do you live out of the city (town)? (INT: Mark whether nearer or farther away from site)
5 - ________________	Number	Including yourself, how many persons are there in your party which is stopping at this particular place?
6 - 1 Immediate family 2 Other relatives 3 Unrelated individuals 4 Other (explain below)		Does your party consist mainly of your immediate family, mainly of other relatives, or mainly of unrelated individuals, such as neighbors and friends?
7 - ________________	Number	Including yourself, how many persons are there in your immediate family?

To help the University figure out how valuable recreation is to the state, I'd like to ask you about your party's expenditures from your home to this area.

8 - $ ______________	Enroute	Approximately how much did your party spend for food and liquor in cafes, restaurants or taverns while you were enroute to this particular site? (just your best estimate)

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$__________ Here About how much will your party probably spend in restaurants, cafes or taverns while you are stopping at this particular site? (just your best estimate)

---

9 - $__________ Home Approximately how much did your party spend for this trip in grocery or liquor stores before you left home? (just your best estimate?)

$__________ Enroute About how much did your party spend in grocery or liquor stores while you were enroute to this particular site? (just your best estimate?)

$__________ Here What do you think your party will spend in grocery and liquor stores while you are stopping at this particular place? (just your best estimate?)

---

10 - $__________ Enroute While you were enroute to this site, about how much did your party spend for lodging in motels, hotels, or trailer parks? (just your best estimate)

$__________ Here What do you think your party will spend for lodging in motels, hotels or trailer parks while you are stopping at this site? (just your best estimate)

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11 - $__________ Enroute How about camping fees--how much, if any, did your party spend for camping fees while you were enroute to this site? (just your best estimate)

$__________ Here What do you think your party will probably pay for camping fees while you are here at this site? (just your best estimate)

---

12 - __________ Miles How many miles, if any, did your party drive yesterday while at this site?

12a - __________ Purpose What was the purpose of your drive yesterday?

12b - __________ Miles (If not at site yesterday) About how many miles, if any, will your party probably drive today while at this site?

12c - __________ Purpose For what purpose will today's drive be for?

Now, please think of the gasoline and oil that will be purchased for your party's car and boat for this entire trip.

13 - __________ % before leaving First, about what percent of gas and oil for the car and boat was purchased for the trip before you left home? (just your best estimate)

__________ % both ways Now, think of all the gas and oil that will be purchased between home and here and between here and back home. Approximately what percentage of the gas and oil will be purchased between home and the time you get back home from here, that is, both ways? (Estimate)

__________ % at this site What percent of all gas and oil purchased for the car and boat will you probably make while you are stopping at this site? (just your best estimate)

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14 - 1 Yes (ask 14a) 2 No (skip to no. 15)	Did your party bring a boat with you to this site?
14a - ________ Gallons Gas	About how many gallons of gasoline does your boat use a day at this particular site?
________ Quarts Oil	How many quarts of oil does your boat use in a day while here?

(INTERVIEWER: Refer to question no. 6. Ask question 15 series only if code 2, 3, or 4 is circled in no. 6)

15 - 1 Mine (ask 15a) 2 Someone else (skip to 15b)	Whose car did you bring on the trip--yours or someone else's in your party?
15a - $________	How much, if any, did other members of your party contribute for gas, oil and automotive expenses thus far on the trip?
15b - $________	How much, if any, have you contributed thus far to the owner of the car for gas, oil and automotive expenses?
16 - $________	How much money, if any, has your party spent on boat launching fees while on this trip?

17 - Thus far, we have talked about expenses for the automobile, boat, food and liquor, and for lodging and camping fees. Can you think of any other types of expenses you have had coming here, such as camera supplies, souvenirs, etc. (If YES) What type?

1 No
2 Yes Type ________
Total cost of these expenses $________

17a - What other types of expenses will you have while stopping at this site?

1 No
2 Yes Type ________
Estimated cost of these expenses $________

18 - (HAND CARD TO RESPONDENT) Here is a list of items which either you or other members of your party may own, which you have brought with you to this site. Looking over the list, will you please tell me which owned items were brought with you? Do not inclue rented items. (INT: Mark X for each item. Then ask remaining questions on your card for each X'd item)

Items	Year Purchased	Amount Paid for Item	Type & Location of Store Where Purchased	Maintenance
____ Boat				
____ Outboard motor				
____ Boat trailer				
____ Fishing tackle (rod, reel, tackle box, etc.)				
____ Camper (van, truck, trailer camper, etc.)				
____ Tent trailer				
____ Tent				
____ Back pack				
____ Sleeping bag				
____ Stove				
____ Lantern				
____ Cooler				
____ Boat equipment not included in price of boat (preserver, fire extinguisher, etc.)				
____ Water skiis, ropes, etc.				
____ Special clothing (such as rubber boots, coats, rainwear, swimming suits, etc.)				
____ Any other items? (If YES) What? ____				
____				
____				

23 -	1 Male	1 Under 21 years of age	
	2 Female	2 21 - 29 years	
		3 30 - 39	
		4 40 - 49	
		5 50 - 59	
		6 60 or over	Age and sex of respondent

24 - ______________________ Site where interview was taken

25 - __________ ______________________ Telephone number of respondent.
Area Code (For verification purposes only)

X I hereby certify this interview was actually taken with the person described above, and represents a true and accurate account of the interview.

______________________ ______________________, 1968
(Interviewer's Signature) (Date)

COMMENTS ON INTERVIEW (if any):

19 - (HAND RENTAL CARD) Looking at this list of items, will you please tell me which, if any, of these items you or other members of your party have rented for this particular trip? (INT: Mark X for each item. Then, for each X'd item, ask the remaining questions on your card for each X'd item)

Item	Rental Rate (Daily, Hourly, Weekly)	Type & Location of Store Where Rented	Total Rent Expected to Pay for Item
____ Boat			
____ Outboard motor			
____ Boat trailer			
____ Fishing tackle (rod, reel, tackle box, etc.)			
____ Camper (van, truck, trailer camper, etc.)			
____ Tent trailer			
____ Tent			
____ Back pack			
____ Sleeping bag			
____ Water skiis			
____ Life vests			
____ Other equipment for boats			
____ Any other items?			
(If YES) What? ____________			
____________			
____________			
____________			
____________			

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20 - $____________________ About how much will you spend at this site for various baits--just that amount that will be used at this particular site?

0 None

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21 - (HAND RESPONDENT INCOME CARD) Would you please look at this card and tell me which one of these groups best fits your total family income before taxes for last year? Just call your answer by letter, please.

1 (a) Less than $3,500
2 (b) $3,500 - $4,999
3 (c) $5,000 - $6,999
4 (d) $7,000 - $7,999
5 (e) $8,000 - $8,999
6 (f) $9,000 - $9,999
7 (g) $10,000 - $10,999
8 (h) $11,000 - $11,999
9 (i) $12,000 - $12,999
0 (j) $13,000 - $14,999
1 (k) $15,000 - $16,999
2 (l) $17,000 - $19,999
3 (m) $20,000 - $24,999
4 (n) $25,000 or over

(INT: If $25,000 or over, get range from respondent)

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22 - INTERVIEWER: Mark below the type of activity the respondent was doing when you first approached (him) (her), or the type of activity the respondent just finished doing.

______________________________ Activity

APPENDIX B

OREGON STATE UNIVERSITY

Hello, I'm ______ _______. I'm conducting a survey for Oregon State University and would like to ask you a few questions about your business if you don't mind. Everything you say is confidential, and the results are tabulated for the area as a whole - not for any one person or business.

1 - $______	First, may I ask what your total sales of merchandise and services were during 1968. This can be either calendar year or fiscal year, whichever is easier for you.
2 - $______ 0 None	What was the approximate amount of your sales to private individuals during 1968? Do not include businesses or government - just private consumers or individuals.
3 - $______	During 1968, did you sell any merchandise or services to government units outside Klamath County? (If YES) What was the total amount of these sales to government units outside Klamath County?
$______ Fed. 0 None	During 1968, did you sell any merchandise or services to government units inside Klamath County? (INT: If NO, circle all three 0's)
$______ State 0 None	(If YES) What was the amount of your sales to government units in Klamath County? What was the amount of your sales to agencies of the Oregon State government in Klamath County? And, what was the amount of your sales to local city and county governments?
$______City/County 0 None	
4 - $______ Outside 0 None	What was the total amount of your sales to businesses outside Klamath County in 1968? Again, either the calendar or fiscal year?
5 - $______ Inside 0 None	What was the total amount of your sales to businesses inside Klamath County in 1968?

6 - Now, would you please think of the sales you made to businesses within Klamath County during 1968. (HAND RESPONDENT CARD) On this card are some types of businesses. As I read off each type, will you please tell me the amount or percentage of your sales, if any, you made to that type of business in Klamath County? (INT: Go through list one at a time. There must be an answer recorded for each type of business. If answer is "None", write in "0" on appropriate line)

$__________ (a) Agriculture
$__________ (b) Agricultural services
$__________ (c) Lumber
$__________ (d) Manufacturing
$__________ (e) Lodging
$__________ (f) Cafes and Taverns
$__________ (g) Service stations
$__________ (h) Construction
$__________ (i) Professional services
$__________ (j) Product-Oriented wholesale & retail (unless listed elsewhere)
$__________ (k) Service-Oriented wholesale & retail
$__________ (l) Communications & Transportation
$__________ (m) Financial institutions
$__________ (n) Grocery wholesale or retail
$__________ (o) Resorts and Marinas
$__________ (p) Auto and Trailer Sales
$__________ (q) Other (Specify__________________________)

7 - 1. Corporation (Ask 8 & 9) 2. Other (Skip to #10)	Is this business a corporation, or some other kind of ownership?
8 - $__________ 0 None	About how much in compensation was paid to corporation officers during 1968? Please include all compensation including bonuses, profit-sharing, and firm contributions to retirement.
8a -$__________ 0 None	How much of this compensation, if any, was paid to officers outside Klamath County?
9 -$__________ 0 None	About how much in wages were paid to employees of the corporation during 1968? Please include all wages including bonuses, profit-sharing, and firm contributions to retirement.
9a -$__________ 0 None	How much of these wages, if any, were paid to employees outside of Klamath County?

(INTERVIEWER: If you asked #8 and #9, skip now to #11. Questions #10 and 10a are to be asked only of businesses which are not corporations)

10 - $_______	Including yourself, how much was paid in wages to all employees of the firm during 1968?
10a - $_______ 0 None	How much of these wages, if any, were paid to employees outside of Klamath County?
ASK OF EVERYONE	
11 - $_______ 0 No purchases (If None, skip to #18)	Did this business buy any new equipment, machinery, buildings, or other capital items during 1968? (If YES) What was the total amount of these capital item purchases during 1968?
12 - $_______ 0 None	Of the capital item purchases you made in 1968, how much, if any, were purchased from individuals?
13 - $_______ 0 None	Were any of these 1968 capital items purchased from government units outside Klamath County?
14 - $_______ Fed. 0 None	Were any of these 1968 capital items purchased from government units inside Klamath County? (INT: If NO, circle all three 0's)
$_______ State 0 None	(If YES) What was the amount of your 1968 capital items purchased from federal government units in Klamath County?
$_______ City/ County 0 None	What was the amount of your capital item purchases from agencies of the State of Oregon in Klamath County?
	What was the amount of your capital item purchases from local city and county governments in 1968?
15 - $_______ 0 None	Of these capital item purchases you made in 1968, how much, if any, were purchased from firms or businesses outside of Klamath County?
16 - $_______ 0 None	Of the capital item purchases you made in 1968, what amount was bought from firms or businesses inside Klamath County?

17 - Now, will you please think of the purchases of capital items which you made from businesses within Klamath County during 1968. On this card are the same types of businesses which you read before. As I call off each type, will you please tell me the amount or dollar percentage, if any, which was purchased from that business

group in Klamath County? (INT: Go through list one at a time. There must be an answer recorded for each business type. (If None, write in "0")

$_______ (a) Agriculture
$_______ (b) Agricultural services
$_______ (c) Lumber
$_______ (d) Manufacturing
$_______ (e) Lodging
$_______ (f) Cafes & Taverns
$_______ (g) Service stations
$_______ (h) Construction
$_______ (i) Professional services
$_______ (j) Product-Oriented wholesale & retail
$_______ (k) Service-Oriented wholesale & retail
$_______ (l) Communications & Transportation
$_______ (m) Financial institutions
$_______ (n) Grocery wholesale & retail
$_______ (o) Resorts & Marinas
$_______ (p) Auto and Trailer Sales
$_______ (q) Other (Specify_______________________)

	ASK OF EVERYONE	(HAND RESPONDENT LIST OF POSSIBLE TAXES)
18	- $_______ Fed.	What is the approximate amount of taxes which your firm paid to the federal government in 1968?
	$_______ State	How much in taxes did your firm pay the State of Oregon in 1968?
	$_______ City/ County	What was the approximate amount of taxes which your firm paid to this county or to cities within the county in 1968?
19	- $_______ 0 No or None	Did your firm pay any taxes to states outside of Oregon in 1968? (If YES) About how much?
19a	- $_______ 0 No or None	Did your firm pay any taxes to city and county governments outside Klamath County in 1968? (If YES) About how much?

20 - 1. Yes (Continue with #21 2. No (Skip to #28)	Did your firm receive any interest, rent, royalties, or dividends during 1968?
21 - $______	What was your firm's total receipts from interest, rent, royalties, or dividends during 1968?
22 - $______ 0 None	How much of these receipts, if any, were paid to you by private individuals?
23 - $______	During 1968, did you receive any interest, rent, royalties, or dividends from government units outside Klamath County? (If YES) What was the total amount?
24 - $______ Fed. 0 None	During 1968, did you receive any interest, rent, royalties, or dividends from government units inside Klamath County? (If NO, circle all three 0's)
$______ State 0 None $______ City/ County 0 None	(If YES) How much was received from federal government? From the Oregon State government? From this county or cities within the county?
25 - $______ 0 None	During 1968, did you receive any interest, rent, royalties, or dividends from businesses outside Klamath County? (If YES) What was the total amount?
26 - $______ 0 None	During 1968, did you receive any interest, rent, royalties, or dividends from businesses inside Klamath County? (If YES) What was the total amount? (If NO, skip to #28)

27 - Again, here is a list of types of businesses in Klamath County. As I read off each one, will you please tell me the amount or percentage, if any, which came from interest, rent, royalties, or dividends from any of these types of businesses within Klamath County. (INT: There must be an answer recorded on each line)

$______ (a) Agriculture

$______ (b) Agricultural services

$______ (c) Lumber

$______ (d) Manufacturing

$______ (e) Lodging

$________ (f) Cafes & Taverns
$________ (g) Service stations
$________ (h) Construction
$________ (i) Professional services
$________ (j) Product-Oriented wholesale & retail
$________ (k) Service-Oriented wholesale & retail
$________ (l) Communications & Transportation
$________ (m) Financial institutions
$________ (n) Grocery wholesale & retail
$________ (o) Resorts & Marinas
$________ (p) Auto and Trailer Sales
$________ (q) Other (Specify____________________)

ASK OF EVERYONE

28 - $________ What was the total amount of depreciation taken by your firm in 1968?

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29 - 1. Higher (Ask 29a) 2. Lower (Ask 29a) 3. Same (Skip to #30) 4. D.K. or no inventory	Was your inventory higher or lower at the end of 1968 than it was at the beginning of the year?
29a - $________	About how much (higher) (lower) was your inventory at the end of 1968?

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30 - X I hereby certify this interview was actually taken with the person listed below, and represents a true and accurate account of the interview.

________________ (Respondent) ________________ (Firm) ________________ (Date)

________________ (Phone Number) ________________ (Interviewer's signature)

FOR OFFICE USE ONLY

Interview verified by____________________

Date of verification____________________

*U.S. GOVERNMENT PRINTING OFFICE:1973 514-152/177 1-3